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SCIENTIFIC AND TECHNICAL MAN-POWER IN BRITAIN

AMONG the specific issues of policy on which the Advisory Council on Scientific Policy was asked to make recommendations shortly after its first meeting in March 1947 were the arrangements for securing an adequate flow of scientific man-power to meet the needs both of Government and of industry. One section of the Advisory Council's first annual report deals with this problem in some detail, and may well be regarded as the most important section of the report. Since the Barlow Committee recommended in May 1946 that the output of scientific workers should be doubled so as to provide about five thousand every year, it has become apparent that attainment of this expansion within the immediate future is improbable, if not impracticable under present conditions. Furthermore, while on one hand the desirability of an expansion at the recommended rate has been challenged on the ground of the probability of the supply exceeding demand, on the other, fears have been expressed that too large a proportion of the available new scientific talent is being attracted to the Government services and that industry is not obtaining the recruits it requires.

In dealing with this task of keeping under review the probable demand for scientific man-power and the measures being taken to meet it, the Advisory Council on Scientific Policy investigated four primary questions: the number of scientific workers and technologists already available; whether the prospective supply of such men and women in the coming decade is likely to meet the expected demand, and, if not, what further steps should be taken to increase the output; and whether the present distribution of scientific man-power between defence and civil requirements is satisfactory. The last of these is clearly the most important question at the present time; but the answer we give to it must depend partly on the situation revealed by the examination of the first three questions. In regard to the first of these, the Advisory Council has discussed with the Ministry of Labour and National Service the possibility of arriving at a more accurate estimate of the existing number of qualified men of science and technologists than the rough calculation of 55,000 given by the Barlow Committee in 1946. The Ministry doubts whether the Central (Technical and Scientific) Register ever included more than about 85 per cent of the qualified scientific man-power in Great Britain, and the Advisory Council accordingly asked the Ministry to make a new survey with the view of ascertaining the numbers available at the present time.

A large number of replies have now been received to the questionnaire issued at the end of October 1947, and analysis of the results is expected to provide a very useful picture of the scientific man-power now available in Great Britain, with full details of the experience, qualifications and occupations of those covered. Further detailed reviews of the man-power position in particular fields of science are being carried out by the Ministry of Labour, and these reviews should also contribute to the more

difficult question of estimating the prospective demand for scientific workers. Some of the recent inquiries, such as that carried out by the Industrial Research Committee of the Federation of British Industries, are admittedly inadequate, and the figure of 70,000 given by the Barlow Committee as the minimum demand for scientific men in the United Kingdom and in the Colonial Service has since been questioned, as well as the further estimate that the effect of raising the school-leaving age and the increasing need for qualified workers in Government service and industry would raise this figure to 90,000 by 1955.

The Barlow Committee estimated that unless the output of newly qualified scientific workers was raised from its pre-war level of about 2,500 per annum to 5,000 we could not expect more than 64,000 to be available by 1955. According to the Advisory Council, the latest figures which have been obtained from the universities indicate that this level has almost been reached and that the present output, if maintained, is therefore likely to meet the anticipated demand. Against this view, it has been stated that the Universities of Oxford and Cambridge will only be able to admit about one in twelve of the student applicants for the academic year beginning this autumn. The Vice-Chancellor of the University of Manchester, Sir John Stopford, has spoken of intolerable overcrowding there, and has told the University Court that the number of students, at present 5,460, might reach 6,000 in October, but after that would have to be kept appreciably below 5,000 until the building programme was under way.

The shortage of accommodation, which has existed since the end of the War, for entrants from school has been due essentially to the policy of giving preference to ex-Service men; but the procedure has naturally reacted harshly on members of the younger generation too young to be called up for several years service in the Armed Forces. The waiting list of ex-Service men with a claim for preference is not yet exhausted, and the majority of those already admitted have still to complete their courses. While this position obtains, even if the standard of acceptances from school reaches a much more satisfactory level than one in twelve, not only must many young aspirants to a university education be disappointed, but also, and equally important for the assumptions of the Barlow Report, the age structure of the intake of scientific workers will be affected adversely, and a longer time will be required before the level is stabilized at whatever figure, whether double or treble the pre-war, for example, may be deemed desirable.

This factor may, however, prove of minor importance compared with the others, such as building extensions and the assembling and training of the teaching and research staff to deal with the increased number of students, which are involved in implementing such a long-term policy as that recommended in the Barlow Report. A Committee appointed by Nuffield College, in its report "The Problem facing British Universities"*, is of the firm opinion that, until additional financial resources can be translated into buildings and equipment, and additional staff collected, the doubling of the university population contemplated by the Barlow Committee is not possible, and even the present increase of a half over pre-war figures is excessive. The provision which the universities can make for other needs—extra-mural teaching, intra-mural part-time teaching, advanced research, and the wide range of advisory work exacted by the Government from university staffs to-day—is stretched to the utmost.

The Nuffield Committee statement casts a very critical eye over the demands for university expansion, and although the Committee appears to be sceptical as to the justification for doubling or trebling the university population, it is unfair to suggest that it is opposed to expansion. It is concerned rather with the best way of dealing with an increased demand in the immediate future, and with the dangers which may result from allowing limited and sectional pressures to distort the balance and scale of university provision. It casts few doubts on the employability of more graduates in the national life; but it is concerned as to the maintenance of the sanctity of university life.

The significant factors with reference to the report of the Advisory Council on Scientific Policy which are stressed by the Nuffield Committee are that the present demands for university expansion represent many conflicting and unco-ordinated pressures. In the aggregate, the estimated requirements of the professions, Government departments and industry for graduates represent a 60 per cent increase on the 1938 numbers. What does not appear to have been considered is how all these demands can be met without fundamentally altering the character and purposes of university education, particularly during the next ten years, when the shortage of teaching staffs is the most critical factor.

It is with this danger in university expansion that the Nuffield statement is fundamentally concerned. It admits the need for expansion, although it reserves judgment as to the magnitude required. It calls for better planning of existing resources, and for more thought about the aims and fruits of a university education. It suggests that before deciding when and how to meet some of the sectional demands for expansion, we should first consider those demands in the light of the fundamental purpose of the university. We may need a re-statement of the principles that should govern the life and work of a university if the demand for training for a career is not to be allowed to distort both the development and the functions of the universities.

The Nuffield statement puts these questions; but it does not attempt to indicate the answers. Its constructive suggestions are designed rather to ease the immediate pressure on the teaching staffs, and two of these are open to serious objection. The proposal to push back to the secondary schools a good deal of the instruction which is at present given in universities runs counter to a fairly general complaint that the schools are already giving much specialized instruction that should properly be given

* Nuffield College. The Problem facing British Universities. Pp. 131. (London: Oxford University Press, 1948.) 5s. net.

in the university. Certainly any increase in the influence of the university on the content of the school curriculum cannot be viewed without some concern that it may be detrimental to the interests of the many scholars who do not proceed to a university at all.

The second proposal is that universities in Britain should leave to the specialized institutions and technical colleges a good deal of the higher professional training that in the United States is undertaken by the universities. The Nuffield College Committee has in mind particularly the development of advanced schools for the study and teaching of engineering and other technological subjects and for the professional preparation of teachers, clergy and possibly others. The development in the United States as well as in Germany and some other European countries of such specialized institutions for advanced study and research is *prima facie* evidence that the suggestion deserves to be examined carefully. The Massachusetts and California Institutes of Technology and the *Handelshochschulen* of Berlin and Stockholm have assembled staffs and made contributions to research and teaching which few universities surpass. What chiefly distinguishes a university from them is a wider range of studies and a less specialized purpose.

Nevertheless, the separation of the study of engineering and other technological subjects from the universities and concentration in special schools, however closely located to the universities or friendly the association with them, has real dangers. In the first place, segregation of engineering and technological students in this way deprives them of the great benefit of a life shared with students in other fields, and may well encourage the narrowness of outlook so often condemned in the specialist. Conversely, not only have the students of engineering and other branches of technology a contribution to make to the corporate life of the university, sometimes out of proportion to their numbers, but also the teacher and investigator in these fields would, by such segregation, be deprived of the fertilizing and stimulating influence of close contact with colleagues working in such fields as mathematics, physics, chemistry and geology.

The first need, as the Nuffield College Committee rightly points out, is to define the specific function of the university and relate it to the functions of other institutions. In this matter of technical training, too, we need not only to be clear as to the justification for university facilities for any particular branch of professional or technological training, but also we need to recognize much more frankly that most occupations involve so restricted a range of theoretical or scientific knowledge that their technique can be acquired just as effectively and much more economically in the occupation than in a university. That is a consideration which bears closely on the correct distribution of scientific man-power, with which the Advisory Council on Scientific Policy is concerned.

A second conclusion reached by the Nuffield College Committee also touches that problem. Whatever the demands made on the universities, there is no possibility of meeting them unless the universities can draw from the schools a sufficient supply of undergraduates to be trained in accordance with those demands. Earlier in its report, the Committee endorses the view of the Barlow Report that in the present phase of expansion the universities must, so far as they are able, give the first priority to increasing the supply of university teachers and research workers. It then points out in this connexion that the fulfilment of even the sectional professional demands that are being pressed depends on the maintenance or improvement and extension of the general education given in secondary schools, and in particular that the universities must do all in their power to ensure that the schools can secure a regular supply of mathematicians, graduates in English and other languages, the classics and in science.

Complaints have been voiced that just as an excessive proportion of our scientific man-power is entering Government service rather than productive industry, so the staffing of schools with honours graduates in science of high ability is becoming increasingly difficult because of the more attractive and remunerative conditions in industry.

That is clearly a matter to which the Advisory Council cannot be altogether indifferent, although in its present report it merely considers the distribution of scientific man-power between defence and civil requirements. The question of higher technological training has been reserved for discussion in a separate report, and the survey of higher technical and other specialized institutions included in the Nuffield statement should prove a useful contribution to that discussion. The Advisory Council takes up the query raised by the Select Committee on Estimates as to the justification for the present distribution of Government research funds between civil research and defence research, and gives the estimate of about 13,700 scientific workers engaged in civil research as against 5,500 in defence research. The former figure includes 10,000 in industry, 2,500 in civil Departments of State and 1,200 in the research associations. The Advisory Council comments that much defence research and development is carried out by industry, while many scientific workers employed by the Government are concerned with subjects such as aeronautics and radar which have important civil applications, even when research and development are undertaken purely for defence purposes. The comparatively high Government expenditure on defence research as compared with civil research is due partly to the fact that the Government has to undertake directly or by contract all research or development for defence, whereas the main effort on the civil side comes from industry, and partly to the high cost of provision for development, design and prototype production in the defence field.

The Advisory Council has thus only touched the fringe of the general problem of scientific man-power, and in particular the question of distribution deserves rather fuller examination. The estimates of distribution in themselves merit analysis: on the figures quoted, qualified scientific workers employed by the research associations represented roughly some ten per cent of those engaged in Great Britain's total

research effort, a proportion sufficiently high to warrant some examination of the question whether it yields a sufficient return in comparison with other forms of research effort. The whole question has a close bearing on the prospective supply, and it may well be found that the promised report on higher technological training will provide the occasion for a more adequate discussion of some of these issues, which require to be resolved before the form of university expansion over the next few decades is finally moulded.

CHRISTIAN HUYGENS

Christian Huygens and the Development of Science in the Seventeenth Century

By Dr. A. E. Bell. Pp. 220 + 7 plates. (London: Edward Arnold and Co., 1947.) 18*s.* net.

FOR many the most fascinating period in the history of science is the second half of the seventeenth century, the time when the foundations for the vast structures of to-day were laid with extraordinary sureness, solidity and speed. Newton, of course, was the supreme figure, a genius whose pre-eminence has been emphatically avowed by all men of science who have closely studied his achievement. The age was, however, rich in figures of outstanding gifts and accomplishment, and among them Christian Huygens holds a foremost place. He was, incidentally, one of the few to whom Newton paid generous tribute. Pemberton records: "But Sir Isaac Newton has several times particularly recommended to me Huygens's stile and manner. He thought him the most elegant of any mathematical writer of modern times, and the most just imitator of the antients . . .", the "antients" for whom Newton always expressed the greatest admiration. In the "Principia" he refers to "Sir Christopher Wren, Dr. Wallis and Mr. Huygens, the greatest Geometers of our time", and, acknowledging the gift of a copy of the "Horologium Oscillatorium", he writes "... Mr. Huygens's kind present, which I viewed with great satisfaction, finding it full of very subtle and useful speculations very worthy of the author. I am glad, that we are to expect another discourse of the Vis Centrifuga." Dr. A. E. Bell, whose book is before us, quotes the familiar "What Mr. Huygens has published since about centrifugal force I suppose he had before me", and adds "wrote Newton with some chagrin", which seems to be a quite unjustifiable comment.

That Newton had a just appreciation of the work of Huygens and fully understood it is significant, because Huygens signally failed to comprehend Newton's full achievement, although he realized Newton's greatness as a mathematician and as an experimenter. He criticized Newton's fundamental work on colour because it did not explain the ultimate nature of colour—"Besides, if it should be true that the rays of light, in their original state, were some red, others blue, etc., there would still remain the great difficulty of explaining, by mechanical principles, in what consists this diversity of colours". He did not understand Newton's "But to examine how Colors may be explained hypothetically is beyond my purpose". Huygens himself wrote little about colour, since the problem as he conceived it, to find a mechanical explanation, seemed to him intractable: "I do not think", he wrote, "that it would be easy to show what makes red or blue colours, nor am I much impressed in this matter by the Cartesian proofs. Certainly it has little or nothing to do with the geometrical method of reasoning."* He may not have been impressed by Descartes' particular views on colour, but nevertheless he himself was seeking a Cartesian type of 'explanation'. Again, he could not accept Newton's gravitating forces acting at a distance; but, although he rejected Descartes' particular way of explaining gravity by swarms of subtle particles, he himself published as late as 1690 a scheme which accounted for terrestrial gravity by a shell of particles round the earth behaving in a somewhat different way from that devised by Descartes. He never, apparently, really understood the essential nature of the advance made by Newton in his great hypothesis of universal gravitation.

To say this is not to disparage Huygens, whose fundamental achievements make a formidable list. His pendulum clock was the first accurate timepiece, and was based upon a thorough mathematical study of the compound pendulum and of oscillations in general; his discussion of centrifugal force constituted a fundamental advance in mechanics; his discovery of the rings of Saturn, a brilliant piece of observation, was conditioned by the great advance which he made in the construction of the telescope; his construction for the wave front by what is known as Huygens' principle is fundamental to physical optics and his treatment of double refraction showed the way for subsequent advances in crystal optics. This, which is only part of his record, is a sufficient performance, without crediting him with the wave theory of light, for which, in the ordinary sense, he can scarcely be held responsible. He is one of the really great figures in physics, and it is quite time that there was a book on him in English.

Dr. Bell's book is divided into two roughly equal parts, the first dealing with Huygens' life and the second specifically with his scientific work. This arrangement has the disadvantage that it leads to a certain amount of repetition, which even extends to a double use of the same phrases and quotations. The biography is simply set down, with a good discussion of the Cartesian influence, which, in spite of the fact that Huygens often disagreed with Descartes on mechanistic details, always remained strong. There is the usual denigration of Hooke: it is, of course, perfectly clear and just that Hooke was incapable of the beautiful mathematical development in which Huygens excelled; but it is not correct to say, as the author does, that Huygens showed as wide a range of activity. I can only suppose that he has forgotten Hooke's work in geology, physiology and architecture, as well as the extraordinary scope of his invention.

The matter of aerial, or tubeless, telescopes is not very clearly handled: the original suggestion came from Auzout, and, so far as I know, no successful use was ever made of them, as anybody who has tried to set up even a model can readily understand. Huygens presented to the Royal Society in 1691 an object glass of 121 ft. focal length, with eyepiece and subsidiary equipment for an aerial telescope. Somewhere about 1844 Admiral Smyth thought of trying to erect it; "the trouble, however, promised to be so much greater than the object appeared to

* "Colores autem quid puniceos faciat aut ceruleos non facile ostendi posse existimo; neque hic multum Cartesianis demonstrationibus permoveor. Certe ad Geometricas rationes minime pertinet."

justify that I laid the project aside". The impracticability of the device is not made clear in the book: a plate of the proposed instrument would have helped, and might have replaced, say, that of the Sebastian le Clerc engraving showing Louis XIV visiting the Académie des Sciences, of which the small half-tone reproduction gives little notion. Huygens' philosophical outlook receives some attention. There are many points, such as Huygens' visits to England, on which one would have liked a little more information; but naturally not much detail is possible in the hundred-odd pages devoted to general biography.

The chapter that introduces the treatment of Huygens' scientific work contains the remarkable statement: "The history of this mathematical treatment of phenomena is usually somewhat briefly dismissed, as if it all resulted from the insight of Galileo and Newton—and all the rest were fools". I wonder what writers Dr. Bell had in mind when he wrote this and the sentence ". . . it is simply not true that the dawn of the seventeenth century brought a universal belief in the operation of physical law and a discredit of magic and mystical agents". Did anybody ever suggest that it did? Huygens' work on impact is well summarized in one chapter. Very properly, a relatively considerable space is devoted to the "Horologium Oscillatorium", a book which contains, besides a detailed description of the pendulum clock, the fundamental work on oscillation in a cycloidal arc, on evolutes—which stresses the interest of the cycloid—and on the compound pendulum, the researches that established the centres of oscillation and of percussion. As Dr. Bell justly says, the fact that Huygens used geometrical methods instead of calculus for finding the moment of inertia makes this troublesome matter for the average reader of to-day. Incidentally, it has been suggested of Huygens, as it has of Newton, that he himself used analytical methods and afterwards threw the work into geometrical form, as being the gentlemanly way to do things. "Quoiqu'elle y soit exposée en grande partie suivant le style de l'ancienne Géométrie, on ne peut douter que l'analyse de *Descartes* ne soit le principal instrument dont il s'est servi", says Montucla. Dr. Bell also directs attention to Huygens' proposal to use the length of the seconds pendulum as a standard of length. It is not, of course, suitable, depending as it does on g, but it is the first indication of a search for a not completely arbitrary unit. The "Traité de la Lumière" is well handled in a chapter headed "The Wave Theory of Light", although the author properly points out that it is not really a wave theory in the modern sense but rather a pulse theory and that the conception of periodicity is nowhere introduced. The construction for the wave front and the wonderful treatment of double refraction are the fundamental advances made by Huygens. The work on geometrical optics that enabled Huygens to make good—and short, manageable—telescopes is briefly described, as are the Saturnian discoveries and the attempts to 'explain' the earth's gravitational field. A separate chapter is devoted to the posthumous publication, "Cosmotheoros", in which Huygens argued that the planets are probably inhabited. This little book achieved some popularity; it appeared in several languages and an edition of the English translation was published as late as 1757. It is, however, strange that Dr. Bell says nothing of "De Ratiociniis in Ludo Aleæ", a little work on probability of which Todhunter records, "This treatise of Huygens continued to form the best account of the subject until it was superseded by the more elaborate works of James Bernoulli, Montmort and De Moivre", nor of the work on coronæ and parhelia. They are surely worthy of mention, at least.

It is, of course, poor criticism to reproach an author for not having done what he has not attempted, and to many criticisms that might be made Dr. Bell would probably reply that he had not written a book for experienced students of the history of science, but for average readers. This, for example, would excuse the omission of any attempt at a bibliography of Huygens' books. It is, however, scarcely an excuse for the almost complete lack of references to sources or, still more, for the great carelessness shown as to names and dates. In the preface Thomas Power is cited when Henry Power is meant; the letter quoted on p. 45 was written by Sprat and not by Bishop Wren; on a single page the titles of two books by Kepler and one by Bartholinus are misspelt. These are but examples. Every author knows that a certain number of typographical errors are unavoidable, and there is no point in citing the number that this book contains. There are, however, too many bibliographical errors—Schott's "Mechanica Hydraulico Pneumatica" is not mainly about perpetual motion; at one place we are told "In 1674 appeared Hook's *Micrographia* with its astonishing mixture of skilful observation, pregnant intuition and mathematical insufficiency", although the correct date, 1665, is given elsewhere; the date cited for Kepler's "Epitome Astronomiæ Copernicæ" (1635) would make it a posthumous work, the true date of the first edition being round about 1620, and so on. These points are not mentioned in a carping spirit, but as indicating that the serious reader must be careful in taking facts from this book without verification. There is much, in fact, to indicate that Dr. Bell has not spent too much time with the books with which a writer on Huygens should be familiar. The "Short Bibliography" given at the end of the book "limited to comparatively modern publications" is also disturbing. It makes no mention of Bosscha's book on Huygens; the German history of physics that it quotes is one of the oldest and least informative; there are no references given for Huygens' mathematical work; if Delambre's history of astronomy is allowed in as a "comparatively modern" work, then Montucla's history of mathematics undoubtedly earns a place. Incidentally, the issue of Newton's "Principia" quoted as "English translation by F. Cajori 1934" was a re-issue of Motte's translation of 1729, although anyone might be pardoned for overlooking the fact. Complaints about the index are a failing of reviewers; but the index here is really deficient. I have noted well over fifty names that are mentioned in the text, many of them more than once, that are not indexed, and under the names indexed only about half the references that actually occur in the book are cited. Subjects are treated in the same perfunctory manner.

The reviewer would not be thought ungracious. He is grateful to Dr. Bell for having produced a book on Huygens and for having sent him for many hours back to the original sources. The book will be useful as giving a brief and readable account of the work of that great pioneer, and, no doubt, widely read. It does, however, require a thorough revision, however modest its aim may be, and it is to be hoped that, by the time that a second edition is called for, the author will have extended his researches.

E. N. DA C. ANDRADE

SPOT TESTS

Qualitative Analysis by Spot Tests, Inorganic and Organic Applications

By Dr. Fritz Feigl. Third completely revised English edition, translated by Prof. Ralph E. Oesper. Pp. xvi + 574. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1947.) 43*s*. net.

ONE of the most striking features of recent developments in qualitative and quantitative analysis has been the increasing use made of micro- or semimicro-methods. This is not, indeed, a modern branch of analysis; some of the old masters worked with very small quantities of materials. Wollaston's laboratory, we are told, consisted at one time of a tray containing watch-glasses, a blowpipe, and similar unimpressive objects, and when he had occasion to need a little calcium phosphate for a blowpipe test, he supplied it by scrapings of an ivory paper-knife. Berzelius created nearly all the chemistry of vanadium with a few grams of material. The so-called spot test, with which the present treatise deals, is also an old friend to most chemists; the use of test-papers and of an external indicator in titrations are examples of its early use.

There comes a time in the history of most branches of science, however, when some enthusiast sees the possibility of large extensions of a method, and by devoted and single-purposed work enlarges the field of some modest plot of knowledge until it becomes an imposing park, stocked with the most bewildering variety of forms. This task has been well performed for the spot test by Prof. Feigl, formerly of the University of Vienna and now in the Ministry of Agriculture Laboratory, Rio de Janeiro, who is well known to all chemists as the leading authority in this branch of analysis.

The book is a complete monograph. It deals with apparatus and technique, with methods, reagents, the exact details of procedure, and the results which may be expected. The field of application embraces metals, acid radicals, free elements, mixtures, organic compounds, and technical materials and minerals. In all cases, the most careful attention to detail is given, so that no user of the book who wishes to carry out any test described in it can have any doubt as to what he must do. Very full references to the literature are given (very few after 1939, and these mostly to the author's own papers), and there is a tabular summary and full indexes.

The reviewer looked up several examples of what might be expected to be found in the book, and was disappointed only once (salicylic acid). In his opinion, the book will find a welcome in all chemical laboratories. The use of spot tests in teaching is a matter on which divergent views will be held, and the reviewer does not think the present book is suitable for general use by students. A separate book, "Laboratory Manual of Spot Tests" (New York, 1943), has been written by Prof. Feigl for this purpose. A feature which struck the reviewer is the extending use which can be made of spot tests in organic analysis; according to the author, this branch of the subject dates only from 1928, and the extensive use of organic reagents in inorganic chemical analysis is also a newer development. Although the remark is not relevant to the present book, the reviewer would like to suggest that more attention should be given in teaching to the reduction in the quantities of materials used in organic preparations by students. There is little point in the teacher in the inorganic laboratory training a student to work with very small amounts of material and with small apparatus when the student, on entering on his training in organic chemistry, is encouraged to work with hundreds of grams and with large bolt-head flasks, as is too often the case because the laboratory manuals specify these quantities. Not only is unnecessary expense incurred, but also the student grows up with an increasing inability to work with the small amounts of material he will normally have available in research work. It has been the reviewer's experience that much of what the student has been taught in the course of quantitative inorganic analysis is undone in subsequent work in the organic chemistry laboratory, where the dirty bench and abundance of material are too often the rule. A short course of work on the lines of Prof. Feigl's manual would do much to restore a sense of proportion.

J. R. PARTINGTON

'HILLBILLY' FOLK-LORE

Ozark Superstitions

By Vance Randolph. Pp. ix + 367. (New York: Columbia University Press; London: Oxford University Press, 1947.) 21*s*. net.

THE Ozark country, or Ozarkland as it is sometimes called, covers some fifty or sixty thousand square miles and extends over the southern half of Missouri, the north-west of Arkansas and a few counties in Oklahoma. Although it is often considered to be a mountainous country, the hills are scarcely more than about two thousand feet, and the country consists of wooded land, gorges and ravines.

The name was first applied to this region by French-Canadian trappers, and the origin of the word is still in dispute, some maintaining that it is derived from Aux Arcs (*bois aux arcs*, wood for bows) and others thinking that it is connected with Azoic Arc. However that may be, the highland country was first settled early in the nineteenth century, and since then, largely owing to the bad soil and poor communications, the region has been to a certain extent isolated, and so has preserved many of the old folk beliefs and customs.

In the present volume Mr. Vance Randolph, who has already written a study of the Ozarks in which he deals with what he calls an "American survival of primitive society", has collected a number of the popular beliefs and practices which are still to be found by the field worker in this region. He attributes the survival of many of these beliefs to the fact that the people made little contact with the outside world since the pioneers came west from the Southern Appalachians. Although many Americans regard these 'hillbilly' people almost as foreigners, the fact is that many of them are of British stock and have been in America since colonial days.

In his discussion of Ozark folk-lore, Mr. Randolph has divided his material into subjects, and the book is really a collection of articles in which the beliefs and superstitious practices of the people are merely assembled without any analysis. In effect, the volume is little more than a catalogue in narrative form, and as such is certainly a useful compilation in

view of the well-arranged index. Passing from beliefs on weather signs, the author goes on to discuss matters connected with crops, domestic management and water finders. These water witches or 'witch wigglers' are clearly ordinary water diviners or dowsers, although Mr. Randolph gives no indication that he is aware of these widespread beliefs. Moreover, it is a little difficult to understand why, when seeing one of these dowsers at work, the author should have "shivered" and felt as if the hair was rising on the back of his neck, a fact which he himself explains by maintaining that there was something "uncanny and obscene" about the divining rod.

Much of the folk-medicine and folk-beliefs concerning pregnancy and childbirth could be paralleled elsewhere, and it would be an interesting study to see how far these could be traced to early British sources. Although from what Mr. Randolph has said it would seem that Ozark superstitions are commonly held and of great variety, it would be a mistake to suppose that similar collections could not be made for other regions in which the population has not been cut off to the same extent as those living in Ozarkland. It is true that the superstitions of these less isolated communities would differ radically from those held in the Ozark highlands, but anyone who receives the lavishly produced catalogues of talismans, amulets and charms which circulate in the United States and who reads the advertisements in the newspapers of California and the Middle-West, will conclude that a study of these superstitions would be as entertaining and informative as those of the Ozark country here so assiduously collected by Mr. Randolph.

E. J. DINGWALL

RECLAMATION OF THE LAND

Land Reclamation

By P. J. O. Trist. Pp. 178 + 15 plates. (London: Faber and Faber, Ltd., 1948.) 15*s*. net.

THIS book gives an excellent account of problems facing the officers of the war agricultural executive committees in their task of increasing food production during the War. It was essential national policy that as much food as possible should be grown at home, and that so far as possible every acre of potentially good land should be cultivated. But several decades of agricultural depression had left their mark in thousands of acres of land being abandoned or being so badly farmed that in 1939 they made no worthwhile contribution to the national larder. Much of this land was potentially fertile; it was merely costly and difficult to keep in good heart and in many areas it had broken most of the farmers who were trying to get a living off it.

Mr. Trist confines himself to the problems facing the Essex Committee, of which he was first a district officer and then the cultivations officer, in deciding which under-farmed or derelict areas should be reclaimed, and the method of reclamation to be used. The soils involved were mainly heavy clays, either in derelict pasture or thorn scrub, and the work involved included clearing hedges, cleaning out ditches, seeing to the drainage system, and discovering the best methods of doing the critical cultivations before a crop was sown on most of the land. On some, however, the far more difficult problems of bush and scrub clearing had to be undertaken. All the multitude of problems arising from lack of experience, shortage of the proper tools and of suitable foremen for the large unskilled and often unwilling labour force that had to be drafted on to the land are dealt with clearly and at sufficient length for the intelligent general reader to appreciate the difficulties that had to be overcome in successfully carrying out these reclamations.

The book has also a great historical value, for it gives a very good account of the workings of many war organisations, such as the set-up of the county war committees, the difficulties of employing and limitations in using the various types of labour that had to be drafted on to the land, and many other of the day-to-day problems that arise when a great effort is needed to increase food production. Let us hope that the agricultural policy of Great Britain will continue to encourage the farming community to keep all their land at a high level of productivity, so that the lessons learnt during the War will not have to be slowly re-learnt if a future emergency arises.

E. W. RUSSELL

EGG-LAYING BATTERY MANAGEMENT

Eggs from Every Cage

Describing Laying Battery Management. By H. E. Swepstone. Pp. 83. (Worcester: Littlebury and Co., Ltd., n.d.) 7*s*. 6*d*. net.

MR. SWEPSTONE has written a book on laying batteries which should be of great value to the large number of beginners who are interested in this latest system of commercial egg production. The battery system is equally suitable for the domestic poultry-keeper with half-a-dozen birds, the commercial poultry-keeper and the general farmer, so that this useful little book should have a very wide reading public. The author has had twenty years experience of poultry-keeping, and after trying several methods he states that the best of all is the single hen laying battery. In fact, he would rather give up than attempt commercial egg production on any other lines. Surely this is ample testimony of the efficiency of this system.

This book is written by a practical man who has made a success of the battery system, and it provides all the information that the beginner is likely to require. There are excellent chapters and diagrams on the construction of houses and cages, the best way to start and the right management to get satisfactory results. The arguments in favour of starting with day-old pullets, or partly grown birds, are fully explored, and the man wishing to rear his own replacement stock will find the chapter on intensive rearing very helpful.

The method of accounting is well explained; but the figures of costs and returns would be very much more helpful to the beginner if they could have been converted to present-day values rather than pre-war. In his foreword, Mr. Swepstone asks the reader to substitute current prices for those given, and although this may present no difficulty to the experienced poultry-keeper familiar with the trend of prices, it is not so easy for the beginner, to whom the book will have the greatest appeal. Nevertheless, this handy little volume is well written in practical language and should be on the bookshelf of every poultry-keeper.

T. E. WHITTLE

SOME BIOLOGICAL ASPECTS OF COLONIAL DEVELOPMENT*

By Sir FRANK STOCKDALE, G.C.M.G., C.B.E.
Colonial Development Corporation

CONSIDERABLE interest is being taken by the people of Britain in Colonial development at the present time, and great importance is attached to the further development of Colonial territories in the interests of their inhabitants, the Commonwealth and the world.

In some quarters, extravagant views have been expressed as to the extent and the speed at which deficiencies of foodstuffs and raw materials in Europe can be met from the Colonies; but such views display ignorance of Colonial food requirements, social customs and habits, the poverty of their soils, the vagaries of rainfall, and the hazards from pests and diseases of crops, animals and men. Many of the Colonial peoples themselves are anxious to see the execution of projects which will develop the natural resources and provide them with a wider field of occupation and standards of living; but the road to achievement will only be traversed successfully if there is careful and sympathetic planning and persistent efforts to overcome difficulties.

Government Policy

Government policy is designed to improve and extend the public services and encourage economic progress so far as natural conditions and resources permit. Twenty years ago, a Colonial territory could only obtain financial assistance for active development through a guaranteed loan, but the Colonial Development Act of 1929 and the subsequent Colonial Development and Welfare Acts of 1940 and 1945 provided increasing State help for Colonial territories for post-war plans and centrally administered schemes of research, education and training, and these plans were designed to lead to better nutrition, water supplies, housing and communications, and in turn to better methods of production and higher standards of life.

To secure expanded economic development, the Overseas Resources Development Act was passed in 1948 establishing the Colonial Development Corporation with a capital limit of £110 million, and the Overseas Food Corporation, capital £55 million. The latter is charged with the execution of the East African Groundnut Scheme, and the former is to undertake projects to aid Colonial development generally, its activities covering agricultural, fishing, forestry and mining enterprises as well as industrial, processing and manufacturing undertakings. All projects must be financially sound, and it is the Corporation's intention to supplement, not supplant, private enterprise. It has already a considerable number of projects under consideration, and several have been investigated on the spot. It will start some projects this year, although shortages of basic materials must involve some delays.

Biological Factors

Biological factors have to be taken into account in Colonial development—particularly in Africa.

Population Issues. The increasing populations, their irregular distribution and the drift to the urban areas, emphasize the need for increased production of foodstuffs for local use; and greater occupational diversification is necessary in order to secure a more balanced economy.

Tsetse. Several species of tsetse flies occur on the African Continent and are responsible for the transmission of diseases to man, game, and domestic stock—accounting to some extent for the uneven distribution of populations and domestic animals. The area in which tsetse occurs is estimated to be seventy-five times the size of the United Kingdom. Tsetse flies are found in more than two-thirds of Tanganyika, and outbreaks of trypanosomiasis still occur. Whereas trypanosomiasis is under better control, thanks to increased knowledge and the production of better organic compounds with prophylactic and curative properties, the movement and resettlement of villages is still necessary. Tsetse research work of the past twenty years, including the study of the bionomics of the species and the ecological factors governing their control, has gradually built up a mass of information of the greatest value. It has been established that tsetse flies are susceptible to changes in environment brought about by clearing or thinning the bush, and successful reclamations of areas from tsetse have been achieved by bush clearing, provided that the subsequent tree-growths in the areas so dealt with have been kept in check. Progress, however, is slow, and large-scale clearing operations, such as those being undertaken by the East African Groundnut Scheme, may show the way to bring tsetse-infested country more rapidly into economic production; but no one can be satisfied about the present position. This is recognized by the authorities. Steps have recently been taken to place tsetse research under central direction, and international collaboration is also being secured on trypanosomiasis. Plans are also well advanced for insecticide dissemination by aircraft and helicopters, though the wholesale use of the new insecticides is not without danger, as many useful insects may be eliminated.

Livestock Diseases. In many parts of Africa these remain a factor which controls the development of animal industries and more satisfactory systems of agricultural husbandry. Rinderpest, the most serious of cattle diseases, still occurs in several territories; and although it had been hoped that in East Africa a check had been made on the disease, there have been recent outbreaks in Tanganyika, all the more serious because of the small number of veterinarians at work in the field.

Locusts. Crop losses of considerable magnitude have been experienced in the past in Africa from swarming locusts; but the extensive campaigns for the control of the desert locust in East Africa, and the successful control of the red locust in Tanganyika, have established the fact that locust plagues can be checked before they assume dangerous proportions provided the outbreak areas are supervised and timely action taken against incipient swarms. Spraying from aircraft can be applied effectively, and it has been clearly established that the results of the patient research work of the last twenty years, which are now being applied, are paying dividends.

Termites. Termites still remain unchecked and cause heavy unrecorded losses throughout the Colonial Empire. There is no British authority in the United Kingdom who has specialized in termites and their control, and it does seem high time to provide for a survey of the termite position in

* Substance of a paper read before Section D (Zoology) of the British Association on September 10.

Colonial territories and for planned research. The establishment of a post at the British Museum (Natural History) for the specialized study of termites has been recommended; but a team for the scientific study of termites and the evolution of satisfactory control measures is warranted. A considerable amount of local knowledge is available in the Colonies about termite damage and the resistance of certain hard-wood timbers to attack. This knowledge requires to be collated and expanded by scientific research, and control measures need to be more generally adopted.

Pests and Diseases. Pests and diseases of plants and animals are also factors which have to be kept in mind. In addition to rinderpest, I need only mention certain virus and fungus diseases, such as the 'swollen shoot' of cacao in the Gold Coast, the 'sudden death' of cloves in Zanzibar and Pemba, the witches' broom disease of cacao in Trinidad, the Panama and leaf-spot disease of bananas, and then pass on to the pests of cotton.

The need for increased supplies of cotton from within the sterling area is great, especially at the present time. Owing to the research work of the Empire Cotton Growing Corporation and other specialists, many new types of cotton suitable to different areas and resistant to some pests and diseases have been evolved. Crop losses from jassids and other pests and certain virus diseases have been checked by breeding new resistant types. 'Stainers' are troublesome but not limiting; but the red boll worm (*Diparopsis castanea*) is the most limiting, and definitely controls expansion of cotton growing in large areas of Central, East and West Africa where the climatic regime consists of a single rainy season followed by a long severe dry period. Effective agronomic methods have been devised; but the use of insecticides may be necessary before cultivation can be expanded without undue risks in large sections of the continent.

Importance of Food Supplies

We in Britain are well aware of the shortages of food supplies; and in certain Colonial territories the people have not enough for satisfactory nutrition. Insufficiency of the B-vitamins, hungry periods between the seasons, serious shortages when the rains fail, definite protein starvation—particularly in the southern parts of the West African territories—all exist. Throughout the Colonial Empire there is a great need for wider variety in diet and a much greater consumption of protein foods if extra effort is to be expected in developmental projects. In Africa, it is probable that the growing populations will absorb the bulk of meat supplies available in the near future, and Colonial Governments must give the highest priority to the food needs of their people and to the stimulation of increased local production of crop and animal products.

Fishing. The fishery resources in the waters of Colonial territories have been neglected too long, and a wide field is open for development by the application of modern technology. The first stage is to establish a measure of the availability of fish in terms of the yield per unit of human and material effort expended in their capture and distribution, and then determine the level to which exploitation can safely be developed. Practical tests are an urgent need.

At a later stage it will be necessary to build up a body of basic scientific knowledge of the fisheries so that the level to which exploitation can safely be developed can be determined.

An ambitious programme of research has been planned, including the development of freshwater fisheries and the establishment of fish farming in several areas. There are obviously vast possibilities of increasing fish supplies by fish farming, and a Government training and research centre is to be established in Malaya.

The whaling industry has been developed largely as the result of the whale fishery investigations of the "Discovery" Committee of the Colonial Office. This industry is an example of complete dependence on fundamental oceanography and marine biology. Through this work the vast biological productivity of the southern oceans is made available for human needs, with a reasonable assurance of a maximum sustained production.

Mechanical Aids to Colonial Agriculture

Colonial agriculture is dependent largely upon peasant producers—many of whom grow their crops on small areas for subsistence purposes. In the main, their husbandry methods and animal industries can be greatly improved, though with the existing tools and the methods in vogue increased productivity is difficult to achieve. The requirements at present are to secure better organisation of farming operations and to test the value of fertilizers and mechanical aids. The effects of the introduction of mechanical implements on the farming economy and the social organisation of the people will require careful study and investigation, as their introduction will necessitate farming units of a larger size, whether cultivated individually or communally. The possibilities of increased soil erosion and dangers from pests and diseases must not be overlooked. Useful lessons will doubtless be learned from the East African Groundnut Scheme.

The East African Groundnut Scheme

There is no doubt that the world shortage of edible oils made it essential that this project should be undertaken. It will have an important influence on the agriculture of Tanganyika and on Colonial development generally. I have recently had an opportunity of paying a short visit to the Kongwa area, where the speed at which equipment could be assembled for bush clearing, cultivation and harvesting has been much slower than had been anticipated. Much of the equipment had to be reconditioned or modified and some new implements evolved; but many of the technical difficulties on the mechanical side have now been overcome, and those responsible are to be congratulated on their achievements. Unforeseen difficulties had to be expected and allowed for—this is always the case in pioneering ventures—but the groundnuts and other crops this year have been free from any serious attacks from pests in the Kongwa area, except for damage to the sorghums in the experimental area. There has been some loss of certain groundnut varieties from wild pig; but no occurrence of the virus disease, rosette, which is capable of causing serious losses, has, so far, been detected. It is very necessary, however, that the research work undertaken by the scheme should be well in advance of requirements, so that outbreaks of rosette and of other pests and diseases can be met when they arise.

An extensive programme of field trials to investigate crop rotations, fertilizer needs, cultivation

methods and groundnut varieties, as well as a large series of observation plots with a wide range of crops have been put into effect this year, and valuable lessons have already been learnt. This work has been given the highest priority, and steps have recently been taken to increase the scientific staff. It is to be hoped that arrangements will also be made for the testing of a wide range of groundnut varieties for resistance and immunity to rosette disease in an area of the territory where the disease occurs in some abundance, as in my view such work can only be regarded as a necessary insurance.

Conclusion

A considerable increase of basic knowledge is being built up as the result of Colonial research work; but there are still gaps in our knowledge. The application of the results of research work also leaves much to be desired. The strengthening of the staff of the British Museum (Natural History) appears to be desirable in the interests of Colonial biological research. Termites, in particular, require further study. It is also necessary that early steps be taken to enable Kew to produce a Flora of East Africa. Such a Flora is not at present available, and its production is essential for further ecological work in the East African territories and for the use of biologists working in these territories.

HIGHER EDUCATION IN THE COLONIES

IT was a graceful gesture by the Sixth Congress of the Universities of the British Commonwealth to devote its concluding session on July 23 at Oxford to a discussion of higher education in the Colonies, and thus to recognize and welcome the youngest members of the academic family.

The discussion, under the chairmanship of the vice-chancellor of the University of London, Prof. Hughes Parry, was opened by Sir Alexander Carr-Saunders with a sketch of the general plans for developing university institutions in the British Colonies and in the Sudan. In addition to the two existing Universities of Malta and Hong Kong, there will soon be, in Malaya, a third university if the proposals of the recent commission are adopted for the fusion of the King Edward VII College of Medicine and Raffles College. Five new university colleges are being established, two on the basis of existing institutions, Gordon Memorial College, Khartoum, and Makerere College, Kampala, serving the East African territories, and three as new foundations, University College, Ibadan in Nigeria, the University College of the Gold Coast, and the University College of the West Indies in Jamaica. These five university colleges are autonomous corporations, governed by councils the composition of which ensures that they are broadly representative of the interests concerned in their territories, including Government, and include an effective proportion of academic staff representatives. Control of all academic matters is vested in academic boards, composed wholly of members of the staff. The students at these colleges will sit for the degree examinations of the University of London, with which the colleges will be "in special relationship". By this arrangement, the University of London, while retaining complete control over the award and standards of its own degrees, is prepared to devise, in consultation with the colleges, syllabuses appropriate to the needs and opportunities of the territories and to associate the local staffs in the setting of papers and marking of scripts in the examinations. After gaining experience in constructing syllabuses for special degrees, in conducting local examinations and in establishing firm standards, the colleges will in due course seek degree-granting powers and become independent universities.

A sum of six million pounds from central funds administered on the advice of the Colonial University Grants Committee is available as a contribution towards the capital needs of this programme (excluding the developments in the Sudan). Grants for recurrent expenditure will have to come chiefly from the local governments, and arrangements are being made for such assistance to be given as block grants for quinquennial periods to ensure a proper degree of independence for the colleges. Academic assistance, technical advice, library services and co-operation in a variety of ways from the home universities is provided through the Inter-University Council for Higher Education in the Colonies. The critical need in the next phase of carrying through these plans for a new university and five new university colleges is for properly qualified staff. The conditions of service, the salaries, the academic freedom, the research opportunities, the responsibility of the work make service in these university institutions attractive, and every effort is being made by Inter-University Council visits and other means to overcome some of the disadvantages that formerly existed in Colonial work such as the relative isolation. Sir Alexander Carr-Saunders concluded by appealing to the Dominion universities to interest members of their staffs in serving in the Colonial institutions, either in permanent appointments or on temporary secondment.

In the discussion which followed the opening address, Mr. Lewis Wilcher, principal of Gordon Memorial College, and Dr. Kenneth Mellanby, principal of University College, Ibadan, paid tribute to the assistance given to their colleges by the Inter-University Council and by the University of London. Mr. Wilcher reported that Gordon College hoped to obtain independent university status within ten years, and emphasized the value of the services which higher education had to render to the Sudanese in their rapid progress towards self-government. Dr. Mellanby stated that University College, Ibadan, was beginning in temporary buildings near the permanent site of five square miles which the Nigerian Government had presented, in addition to making a contribution of £500,000 towards the recurrent expenditure of the College in the first quinquennium, and an initial grant of £250,000 to an endowment fund. The College would have two hundred students in residence for the session 1948–49, and expected an annual intake of a hundred. Local groups were springing up throughout Nigeria to collect funds to be placed at the disposal of the College for awarding scholarships.

Mr. H. R. Raikes, vice-chancellor of the University of the Witwatersrand, hoped that the Colonial medical schools would ensure that the students' training made full use of the special opportunities provided by the local clinical material and experience, and pleaded that dentistry should be treated as of equal importance and urgency as medicine; he suggested that external examiners going to the Witwatersrand from the

United Kingdom should be encouraged to visit the Colonial medical schools *en route*. Dr. E. G. Malherbe, principal, Natal University College, stressed the dangers of mass literacy campaigns and elementary education in Africa in exposing the peoples to irresponsible propaganda and to some of the less-desirable features of Western civilization if they were not accompanied by the parallel process of providing the enlightened leadership and critical interpretation which the Colonial university institutions would give.

Dr. J. W. Davidson (Wellington University College, New Zealand) directed attention to the danger of importing into the Colonies European standards and conceptions of university education insufficiently adapted to the conditions and interests of the local communities, and thus losing deeply rooted popular support for the new colleges. Prof. A. R. Humphreys, of Leicester, suggested that a practical step to remove one of the deterrents to recruitment, namely, fear that it would be difficult to return to home university posts, would be the prompt and systematic notification of appropriate vacancies to staffs serving overseas.

Principal H. J. Page described the activities of the Imperial College of Tropical Agriculture, Trinidad, the primary task of which is postgraduate training in tropical agriculture of students entering the Colonial agricultural services; a secondary function has been training students, chiefly from the West Indies, for a local diploma. The College hopes soon to co-operate with the University College of the West Indies in providing teaching for the London degree in agriculture. Mr. Bernard Williams, dean of the Medical School, described the plans for opening the Faculty of Medicine of the University College of the West Indies in October, the special problems created by the scattered territories of the West Indian Colonies, the assistance which the College had received not only from the Inter-University Council and University of London, but also from McGill University, and the methods by which it was hoped to overcome the technical difficulties in the secondment of clinical teachers.

Prof. W. E. Dyer, principal of Raffles College, Singapore, stressed the importance of the secondment of university teachers to the Colonial colleges as a means of reducing the isolation and fear of loss of academic status of the local staffs. Prof. F. L. Warren, Natal University College, considered that one reason why a greater number of French than British scholars had remained in service in Egypt was that staff seconded there from the Sorbonne or University of Paris were granted in two years the seniority which would accrue from three years service in France; he suggested that the overseas institutions would attract visiting specialists if they made it known that they could offer working facilities and cheap residential accommodation, such as were provided for visiting astronomers and marine biologists in Egypt.

Prof. Lillian Penson, of the University of London, in concluding the discussion, stated that every effort was made, through full consultation with local opinion and by other means, to harness the sympathy and support of the peoples to their university colleges, and that, far from any forcing of standards by the University of London or the Inter-University Council on the local communities, the demand for the highest standards and nothing less came from the peoples themselves. Secondment on temporary service to the Colonial colleges gave an opportunity of attractive work; from her knowledge of the quality of Sudanese students, she felt confident that staff need have no fear of lowering standards; and the risk of isolation or of being lost sight of was greatly diminished by the work of the Inter-University Council, particularly by its regular visits.

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, PRINCETON

By Dr. J. A. V. BUTLER

MANY scientific workers will have heard, with regret and possibly incredulity, of the impending closing of the Princeton Laboratories of the Rockefeller Institute for Medical Research. The decision to close these Laboratories and to concentrate the work of the Institute in New York was reached in the spring of 1947. The Laboratories are to be closed by 1951; but if an acceptable offer for the site and plant is received before then it will be accepted. Any members of the staff who wish to do so may continue their work in the New York Laboratories.

It would be impertinent to question the reasons which have led to this decision; but friends of the Laboratory, as well as many who have been privileged to receive its hospitality, will be distressed that it should be necessary. The founding of the Princeton Laboratories was a logical consequence of the policy of the Rockefeller Trustees to provide facilities for the study of disease in all its manifestations, in animals and plants as well as in human beings. This policy was magnificently justified by the results achieved, and to an onlooker it seems a grievous and deplorable loss to science that it should be found necessary to reverse it.

The Rockefeller Institute began its work in a temporary building under Dr. Simon Flexner in 1904. The present New York buildings on a site overlooking the East River were begun in 1906 and have provided both a hospital for the study of special diseases and a wide range of laboratories covering all branches of biochemistry and physiology.

The policy of the Trustees to study disease in all its forms led to the establishment in 1914 of the Department of Animal Pathology with laboratories on a country site near Princeton, under Dr. Theobald Smith, who was succeeded in 1930 by Dr. Carl Ten Broeck. In 1931 the plan to provide, in one organisation, for the study of disease as it occurs in all the main orders of living things was completed by the addition to the Princeton establishment of a Laboratory of Plant Pathology. The Princeton Laboratories also housed a Laboratory of General Physiology, under Dr. J. H. Northrop, which has devoted itself to investigations of the nature of enzymes and other biologically active proteins of animal origin.

The world-wide reputation of the Princeton Laboratories was based in part on the isolation of a large number of crystalline enzymes and their precursors in Dr. Northrop's laboratory, and on Dr. W. M. Stanley's isolation of the tobacco mosaic virus and succeeding studies in the Department of Plant Pathology. Although the first isolation of a crystalline enzyme was achieved by Sumner in 1926, it is not too much to say that the work of Northrop and his

colleagues, leading to the purification and crystallization of a long series of enzymes and related substances, has done more than that of any other group to open up the chemistry of enzymes; while, as is well known, Dr. Stanley's work decisively initiated the modern studies of virus particles. Numerous discoveries in animal pathology were also made within the laboratories, for example, Shope's rabbit papilloma, and many others, which the writer regrets he is unable to describe adequately.

It is most regrettable that the staff and equipment by which such results have been achieved should be dispersed. The main reason for the decision is apparently the contraction of the funds available and also a desire to concentrate the available resources on the Hospital and its auxiliary laboratories. It is understood that attempts made to enlist sufficient financial assistance to make possible the continuation of the Laboratories as a scientific unit were unsuccessful. Many of the younger members of the staff and some senior ones have already accepted posts elsewhere.

The result is the dispersion of a most valuable scientific establishment, which made a contribution to biological and medical research of unique importance. Situated a few miles from the university town of Princeton and within easy reach of New York, it was an ideal site for scientific work. The many British workers who enjoyed its hospitality will remember the efficient organisation of its well-equipped Laboratories and the friendly and agreeable atmosphere of its club-house, and will regret its passing acutely.

RADIATIONS AND HEALTH

A DOSE of radiation above the accepted tolerance limit of 0·5–1 roentgen per week presents hazards to the individual, notably those of sterility and cancer, and to his progeny—in the form of recessive mutations. The importance of the former effects has been recognized since the beginning of the century mainly as a result of the all too obvious injury to many of the early workers with radium and X-rays. The medical profession is therefore fully alive to these dangers. On the other hand, whereas the practitioner sees many examples of the effects of recessive mutations in man—the amaurotic familial idiot, the hæmophiliac, the alcaptonuric—he is seldom, if ever, able clearly to relate these to radiation effects. Thus the matter of genetic damage stands outside the field of practical medicine, and indeed so far has been largely a theoretical concern of eugenics.

Several new factors are at work which must ultimately alter this position. One is the recognition, now beyond dispute, that the genetic effects of radiation are cumulative. The increase in the mutation-rate is proportional to dose, no matter how long may be the period over which it is accumulated. It is estimated, for example, that a dose of 50 r. doubles the mutation-rate in man[1]. It will be noted that the tolerance dose, if regularly received over a reproduction life-time, represents approximately 750 r. It is in no sense a threshold value, and finds general acceptance only on the understanding that not more than 1 per cent of the population receives it regularly. In these circumstances the genetic effects are reckoned to be not more serious than other inevitable ones. The same effects would be produced by a dose of 75 r. incident on 10 per cent of the population. Another factor is a fuller realization of the high levels of radiation to which the population is being subjected as a result of the increasing popularity of X-rays and radium in a wide variety of uses. Especially is this true of the diagnostic and therapeutic uses. At one extreme, doses of the order of 10,000 r. are given in the deep X-ray treatment of malignancy, fortunately to sterile patients, and at the other a diagnostic screening after a barium meal accounts for 10–15 r. delivered directly to reproductive cells. Between the two stand a variety of conditions not in themselves fatal for which radiation is used; for example, ringworm and warts, and especially sterility in women, and on top of them come new treatments with radioactive isotopes. Finally, and most important of all, there stands in the background the sinister threat of an atomic war.

From the points of view of cancer and sterility, it is clearly in the interests of everyone to see that his accumulated radiation dosage both to tissue and reproductive cells is kept at the lowest possible level. He cannot know what the future has in store for him. From a national point of view, it is equally imperative that the level of peace-time radiation should be kept low. The people will be proportionately better able to tolerate the higher doses associated with preparation for, or the actuality of, an atomic war. The ultimate survival of a nation, if not indeed of the population of the world, may depend on just such a piece of elementary prudence as this. Peace-time levels cannot be ignored on the grounds that they are insignificant in relation to the radiation energy which may well be released in an atomic war. As Muller[2] has pointed out, much of the latter will not reach humans at all, and of the proportion which does, most of it will kill outright or sterilize. The insidious danger to the survival of the population lies in the breeding residuum, which will contribute a large number of recessive mutations to future generations. If these are already dangerously undermined in their genetic material by a wanton peace-time use of radiation by their forbears, the results will be serious.

These considerations require as a very minimum that public and scientific attention should be directed to the field of radiations and health in the broadest sense. In some measure, with this end in view, the Radiology Section of the British Medical Association at its Cambridge meeting held a symposium on the therapeutic applications of radioactive isotopes. The physical basis of the subject was presented in an opening paper by Prof. O. Frisch (Cavendish Laboratory), who dealt in particular with the various nuclear reactions which lead to the production of radioactive isotopes. Dr. A. S. McFarlane (National Institute for Medical Research) followed with a review of recent tracer applications, emphasizing the opinion that greater ultimate advantage will probably accrue from biochemical applications with the discovery of precise metabolic pathways in view, rather than from the more spectacular non-specific uses, as, for example, to measure blood-cell volumes or thyroid function.

The main contribution came from Prof. J. S. Mitchell, occupant of the newly created chair of radiotherapeutics in Cambridge. From his wide review covering all isotopes used therapeutically by external and internal administration, it is perhaps justifiable to refer in particular to his statements in relation to sodium-24, phosphorus-32, and iodine-131. These isotopes are usually administered internally,

the first two being especially hazardous because, unlike most forms of therapeutic radiation, by virtue of their widespread distribution, they affect both reproductive and somatic cells. Iodine, on the other hand, is localized to the extent of 80 per cent in the thyroid gland, and this enables doses of 5,000 r. to be given which are effective in destroying glandular tissue in hyperthyroidism. The method is not to be preferred to surgery; but has a useful field of application where other considerations preclude surgery, or in recurrences after surgery. There is a definite risk of late carcinogenesis which is generally worth taking. Few thyroid carcinomas take up useful amounts of iodine, so that isotope therapy is of little value in most malignant conditions of this gland.

Phosphorus-32 given as inorganic phosphate spreads widely throughout the body. Although it is an important constituent of nucleic acid, and practically all tumours are highly nucleated, the differential concentration never approaches that of iodine in the thyroid and generally is too low to be therapeutically useful. However, supplementary X-rays may be used. Prof. Mitchell stressed particularly the value of chemotherapeutic research directed to the synthesis of phosphorus compounds which will become localized in tumour cells. The concentration factor may be increased by local injection of the drug, and the biological half-life of the isotope may be prolonged. The latter incidentally is a composite function of the physical half-life and the excretion-rate. For phosphorus-32 it is estimated to be 11 days for body phosphorus and 6·3 days for thyroid iodine, which compares with physical half-lives of 14 and 8 days respectively.

Phosphorus finds its most effective application in generalized conditions, such as polycythæmia vera and the leukæmias. For the former it is now the treatment of choice, 6–8 millicuries being sometimes effective in a single dose. Generally, however, the disease is kept in control by repeated treatments. The isotope is easily given, the results are better than with external radiation and there are no toxic reactions. It is of interest to note from the hazard point of view that a single dose of 8 millicuries of phosphorus-32 equally distributed in a 70 kgm. adult delivers 70 r. The danger may be observed by the fact that 10 per cent of polycythæmia cases in any event develop into chronic leukæmias; but a few acute leukæmias have been observed after phosphorus treatment. Here again, in Prof. Mitchell's view, the general clinical picture usually justifies the risk.

The initial popularity which phosphorus-32 enjoyed in the treatment of myeloid leukæmia seems to be passing. The high doses used are associated with serious risk to reproductive organs, bone marrow and lymphoid tissue. Most of the isotope is ultimately excreted through the kidneys, and insufficient information is available about remote renal effects. Isotope treatment without supplementary X-rays is valueless in lymphadenoma (Hodgkin's disease), in acute leukæmias of any kind and in tumours. The same remarks apply to sodium-24.

A lively discussion followed, from which it was obvious that the audience much appreciated in particular Prof. Mitchell's survey and shared his cautious attitude in the present limited state of our knowledge. Among various hazards discussed was that arising from the inhalation of particulate radioactive matter. This is present, for example, in laboratories carrying out incinerations of carbon-14 compounds. A minute amount of isotope may ultimately exceed the carcinogenic dose at a point of focus in the lung, since the physical half-life is much longer than the life-span of the individual.

A. S. McFarlane

[1] Ellis, F., *B.J. Radiol.*, **1**, 21 (1948).
[2] Muller, H. J., *Bull. Atom. Scientists*, 207 (Sept. 1947).

OBITUARIES

Mr. P. J. Barraud

It is with deep regret that many of his friends and colleagues will have received the news of the death on August 9, after a long illness, of Mr. P. J. Barraud, at a nursing home at Bournemouth. I first came to know Mr. Barraud, as did a number of others in the Government of India Bacteriological Service, as entomologist attached to the Central Laboratory, Busra, during the latter part of the Mesopotamian campaign in the First World War; but he had earlier in the War done valuable work in the R.A.M.C. in Salonica and Palestine, where he received his commission as captain. Later, in 1922, Barraud was appointed entomologist on special duty under the Indian Research Fund and attached to the Central Research Institute, Kasauli, to carry out research and make a comprehensive survey of the culicine mosquitoes of India, a subject which at the time was very much in need of revision.

Between 1922 and 1932 Barraud published some forty papers describing systematically group after group of mosquitoes with descriptions of large numbers of new species, the final results being published in 1934 as the volume in the Fauna of India series, "Megarrhine and Culicine Mosquitoes of India", a work which was almost unique in its scope and clarity of treatment and which still remains the most comprehensive treatise on Oriental Culicidæ yet published. From at most a few score of recognized species Barraud's work resulted in the description of the adults and early stages of nearly 250 species. At one time he had some difficulty in finding names for all the new species he was describing, and at the present time, out of about 250 total species known from India, more than sixty will be found under Barraud's name as describer.

When in 1925–27 the Kala Azar Commission was formed to investigate the method of transmission of this disease, Barraud was selected as one of its members, and during the time that the Commission was at work he contributed many papers in his own name and jointly with that of other members relating to kala azar and the sandfly *Phlebotomus argentipes*. Besides his more purely laboratory work, Barraud took a great interest, and played an active part, in the training of officers and other staff in the malaria courses held at Delhi by the then Malaria Survey of India (now Malaria Institute of India), and in this connexion he was the author of a very helpful practical entomologist's course for students of malariology (Health Bulletin Series No. 18, published by the Government of India).

After his retirement at Colehill and until his health failed, Barraud played a very active part during the Second World War in local salvage and other local war activities, and was vice-chairman of Colehill Parish Council. He was not only very highly esteemed by his colleagues in India, but also remained the

friend of many of them up to the time of his death. His unassuming kindness and interest in those he came in contact with made him a general favourite socially, and he was a very fresh and companionable friend. He entered with zest into the work and interests of those whom he knew and would take endless trouble to help where his services could be brought usefully to bear. S. R. CHRISTOPHERS

Prof. C. Perrier

NEWS has been received of the death of Prof. Carlo Perrier, professor of mineralogy in the University of Genoa, Italy. Prof. Perrier was born on July 7, 1886, in Turin. He studied in that city and obtained his doctorate in chemistry at the University of Turin. Shortly thereafter he worked for some time in the laboratory of Baur in Zurich on physical chemical problems. On his return to Italy his interest turned to mineralogy, and he joined the school of F. Zambonini.

In 1926 he became professor of mineralogy in the University of Messina, and later he moved to Palermo and finally to Genoa. His work was mostly on crystallochemistry, and he brought to it a remarkable analytical skill and a deep knowledge of crystallography.

Perrier had a wide range of interests and a versatile mind, and when the occasion arose, he was quick to apply his various skills to new problems. Noteworthy among these were the study of technetium carried out by radioactive methods in Palermo in 1936–37 and the investigation by radioactive tracers of some biological and chemical problems. His merits were recognized by membership of several Italian learned societies, including the Academy of the Lincei.

He was a loyal friend and a good teacher, and his untimely death will be deeply regretted by everyone interested in the future of science in Italy.

NEWS and VIEWS

St. Anthony's College, Oxford

AN anonymous Frenchman has given £1,250,000 to the University of Oxford for the foundation at once of a new residential college, with the ordinary status of an Oxford college. Its name is to be St. Anthony's; and its head is to be called the 'warden'. It will start with seven or eight fellows and about fifty graduate and undergraduate members. It will be governed at first by the warden and fellows in conjunction with a St. Anthony Foundation, called into existence recently to carry out the benefactor's wishes. It will be accommodated in the first large house with grounds that can be secured in the vicinity of the University, so that this generous new venture may become visible in the life-time of its founder. He himself has little connexion with England and none with Oxford. His name, if disclosed, would convey nothing to the academic world; but, like Cecil Rhodes, he has admired Oxford men in positions of responsibility all over the world, and has become convinced that the British system of education has promoted initiative and strengthened the moral qualities of students better than any other. Again, like Rhodes, he is anxious that men from overseas should go to Oxford. He has asked, therefore, that in the new St. Anthony's College a substantial proportion of the places available should be kept for qualified graduates from French universities. To encourage undergraduate members to come from France in far greater numbers in the future than they have done hitherto, he has offered a further £250,000 to be divided among any existing Oxford colleges that propose to build additional sets of rooms for their men, provided that in these new sets one third of the places are kept for Frenchmen.

The new proposal was welcomed in a hastily summoned Congregation at Oxford on September 15. St. Anthony's will have the uphill task of all new educational institutions at the present time; but if it contributes something fresh and vigorous to Oxford academic life, as have all the colleges founded in the past hundred years—the five women's colleges, Keble and Nuffield Colleges and St. Peter's Hall—it will do good work. It is a mistake to think that Oxford has all the colleges it needs and that benefactors would be wiser in giving their money to the University itself for furthering teaching and research than to the colleges to strengthen their tutorial system and collegiate activities. This is exactly the time when new colleges are wanted and when some of the existing colleges need further endowment if they are to retain to the full the tutorial system that is so excellent a part of Oxford life. Relative to even the richer colleges, the University in its role of promoter of teaching and research is very well off. It has its own endowments. It has a substantial income from the colleges (which contribute anything from a few hundreds to about £30,000 yearly, according to the college's capacity to pay) and a large one from Government through the University Grants Committee. Colleges, on the other hand, get nothing from the central body of the University and nothing directly from any Government source. They have their endowments; but the increases in their incomes from these sources have, in recent years, lagged behind those of their outgoings. It is on the colleges that the main burden of catering for the large increases in the numbers of men and women in recent years has fallen. It is good, therefore, that St. Anthony's College has been founded. It is hoped that its foundation may stimulate other benefactors to help other colleges as they go forward to their post-war tasks.

Administration and Anthropology

THE Frazer Lecture in Social Anthropology delivered before the University of Liverpool on October 23, 1946, by Dr. E. W. Smith, has now been published under the title "Plans and a People —A Dynamic Science of Men in the Service of Africa" (London: Lutterworth Press, 1948. 3*s.* 6*d.* net). Dr. Smith reviews first some developments in anthropology since 1908, stressing particularly that the study of acculturation in Africa is very largely the study of a disintegrating society and that our prime purpose in social anthropology is to study African society for its own sake, to understand how

its component parts function, what changes are taking place in it and in what directions it tends to develop. Delay in publication has enabled Dr. Smith, in succeeding chapters on the new dynamic Colonial policy, advances in sociological research and the place of anthropology in planning, to take account of events since the address was given, and to assess how far the purpose of government is now not merely the maintenance of security and order but also the general social betterment of the people, and the extent to which the five-year and ten-year plans which Colonial governments have drawn up in broad outline meet his criteria for success. He points out that the recent review of the Colonial Empire, 1939–47, recognizes the importance of research into the nature of native society and its institutions, and he believes that the International African Institute has not only influenced the progress of social anthropology in Great Britain but also the British Government's decision to finance scientific research in Africa. He agrees that the value of social anthropology to the arts of politics and administration depends upon its theoretical advance, but holds that there is room for anthropological study which is at once scientific in method and directed towards the solution of practical problems. While we may differ as to ultimate values, there is much common ground, and in the spheres of nutrition, education, and the improvement of economic and social conditions the anthropologist may join his efforts with those of other scientific workers.

University and Research Section of the Library Association

THE University and Research Section of the Library Association held its twelfth week-end conference during September 10–13 at the University of Birmingham. It was attended by ninety members, with Dr. Arundell Esdaile in the chair, and colleagues from Australia, Denmark, India, Sweden and Venezuela were present. The conference was welcomed to Birmingham by Dr. Wilfred Bonser, University librarian, who outlined the plans for the new University Library to be erected at Edgbaston. The chief speaker at the conference was Dr. S. R. Ranganathan, president of the Indian Library Association and formerly librarian of the University of Madras. Taking as his theme "The Challenge of the Field of Knowledge", Dr. Ranganathan pointed to the declaration made at the Royal Society Scientific Information Conference that in future librarians must be regarded as equal in standing to fellow men of science employed in research, industry and administration, and that they should receive comparable training facilities, rank and emoluments, as marking a definite advance. He showed how difficult it is for the librarian to satisfy the many needs of scholars—and especially of scientific workers—as the various fields of knowledge continually expand and overlap, particularly as seen from the point of view of library classification schemes. He demonstrated the principle and practice of the scheme known as Colon Classification, of which he is the author. During the week-end, visits were paid to the various sections of the University and other libraries at Birmingham, and the information departments of the Austin Motor Works and of Imperial Chemical Industries (Metals Division). The formal business of the annual general meeting of the Section on September 12 was followed by an account by Mr. C. C. Barnard, librarian of the London School of Hygiene and Tropical Medicine, of a visit to Hanover in May of this year as a representative of the Section at a conference of German librarians. The Medical Sub-Section held a meeting devoted to a symposium on cataloguing problems in medical publications, and also visited the Birmingham Medical Institute.

Elimination of Water from Wet Crude Oil

IN a paper on the "Elimination of Water from Wet Crude Oil obtained from Bituminous Sand by the Hot Water Washing Process", by K. A. Clark and D. S. Pasternack of the Research Council of Alberta, University of Alberta, Edmonton (Reprinted from *Canadian Chemistry and Process Industries*, 1947), the authors deal with this problem from two angles, by continuous settling at atmospheric pressure and settling under pressure with evaporation; they have carried out much laboratory work towards its solution. In the first case, wet crude oil from the separation plant is mixed with a diluent (either 'topped' crude oil with S.G. 0·85 or kerosene with S.G. 0·82) and subjected to continuous settling in a suitable laboratory plant (illustrated). A ratio of diluent to crude oil of 0·7 and settling temperature 180° F. results in reduction of water content from 40 to 11·5 per cent. It is found that boiling and frothing of wet diluted crude oil before feeding to the continuous settler improves settling of water by causing coalescence of finely dispensed water, hence increase in volume of water ultimately settling out. The authors emphasize that continuous settling of diluted crude oil is not the complete answer to total elimination of water and that a subsequent operation is required to reduce the amount of finely dispersed water to limits acceptable to a refinery. Concerning mineral matter normally associated with the crude oil, it is pointed out that sand and silt readily settle out; but finely divided clay matter is carried within the finely dispersed water, possibly acting as a stabilizer, and this does not settle out, presumably because the emulsion will not break down under the conditions obtaining.

In an attempt to formulate the 'subsequent operation' above, experiments were carried out with continuous settling under pressure at an elevated temperature; but it was found that heating diluted oil up to 323° F. in this way did not cause finely dispersed water to coalesce. Further, water which does settle, does so as a gelatinous emulsion which will not flow to the discharge valve unaided by mechanical means. Hot oil and water, as is well known, make an unsatisfactory mixture at all times; but it is worse than ever with bituminous sand oil. The conclusion reached is that pressure settling is not practicable, that atmospheric settling of diluted crude oil is the first step, to be followed by evaporation in a heater and steam separator; in this way a practically dry oil can be obtained from bituminous sand, one which can then be more easily refined.

An Attempt to Detect the Magnetic Field of a White Dwarf

DR. A. D. THACKERAY has now published a description of his attempts to test Blackett's prediction on the magnetic field of massive rotating bodies (*Mon. Not. Roy. Astro. Soc.*, **107**, 5 and 6; 1947). Blackett pointed out that the ratio between the magnetic moment and the angular momentum of the earth and sun was approximately the square root of the gravitational constant divided by the velocity of light, and that this also applied to 78

Virginis (*Nature*, **159**, 658; 1947). He also dealt with the application of this formula to the white dwarfs and showed that in the case of Sirius B the equatorial field might be as much as 3×10^8 gauss. Such a field should lead to Paschen–Back splitting of the hydrogen lines of the order of 50 A., and Thackeray gives a full description of his work with the 36-inch Common reflector at the Solar Physics Observatory, Cambridge, to detect this effect. Unfortunately, there is not a very wide choice of white dwarfs suitable for the experiment, and Wolf 1346, magnitude 11·3, was selected as it was attainable with a 1-prism slitless spectrograph attached to the 36-in. reflector. It was shown that Paschen–Back splitting of $H\gamma$ is unlikely to exceed 8 A. in this star, corresponding to an upper limit of 10^8 gauss. It is emphasized that there is need for greater spectral purity in a discussion of an apparent structure in the lines, which is independent of the polarizing analyser. When 40 Erid. B became accessible in September 1947 a 2-in. $f/1$ aspherical singlet, figured and lent by Dr. C. R. Burch, was attached to the Newall 25-in. refractor for an attempt with the Wood aluminized grating spectrograph. An hour's exposure without 'Polaroid' was obtained on September 25, showing $H\gamma$ only, but exposures of one hour on September 25 and 3½ hours on September 27 through the analyser failed owing to the formation of thick haze during exposure.

Recession of Glaciers

THE Royal Geographical Society has inaugurated its new *Research Series* with a paper by Prof. H. W. Ahlmann on glaciological research on the North Atlantic coasts (London: Royal Geographical Society, 1948. 7*s*. 6*d*.). Prof. Ahlmann puts together his own and other observations on glaciers in Norway, Iceland, East Greenland and Spitsbergen. All data point the same way, to a general recession, and the same is true in many other parts of the world. The present rapid shrinkage seems to be the last stage in a recession that began about two hundred years ago when the glaciers reached their maximum extension in historical, and perhaps in post-glacial, times. This recession has resulted too in a rise of sea-level, as noted by J. Thorarinsson, F. Bergsten and others. The increasing intensity of the recession is also shown by recent changes in the extension of the Arctic pack-ice, notably in the Russian Arctic and around Spitsbergen, the northward migration of fish and certain birds and the improved cereal prospects in Iceland. The phenomenon is so widespread that it would appear to be associated with climatic fluctuations. The chief meteorological cause is held to be due to increased ablation. Radiation plays a part; but conduction is more important in the smaller icefields and at lower altitudes. On the other hand, it is stated that in the high interior of the Greenland ice there has been no increased ablation or reduced thickness of the ice. The low-pressure area of the North Atlantic apparently has moved to the north in recent years, thus favouring the flow of warm air to the Arctic.

Gresham's School Natural History Society

THE twenty-sixth report of Gresham's School Natural History Society (1948) has just been received. Membership of the Society totals well over a hundred —an eminently satisfactory number for a school. The Society is divided into Archæological, Astronomical, Botanical, Entomological, Meteorological and Ornithological Sections, all of which carry out valuable field work and present reports and papers to the Society. In the present report there are: (1) a survey of the flora of Holt and district, with an exhaustive list of plants observed; (2) an account of the surrounding insect fauna, together with lists of Lepidoptera and Orthoptera; (3) a descriptive account of the birds of the area, with a very comprehensive list and a detailed study of a fulmar colony. Extracts of papers submitted for the Holland–Martin Natural History Prizes (1944–47) are appended. The boys of Gresham's School are to be congratulated on their efficient and very valuable Natural History Society, which obviously encourages practical and field work to the utmost—a fitting basis for later work in natural history, and a great asset in their general education.

Dr. Franz Weidenreich on Human Evolution

A NUMBER of interesting papers by Dr. Franz Weidenreich are to hand. "The Trend of Human Evolution" is published in *Evolution* (**1**, No. 4; Dec., 1947), and "Some particulars of skull and brain of early hominids and their bearing on the problem of the relationship between Man and the Anthropoids" appears in the *American Journal of Physical Anthropology*, **5** (N.S.), No. 4 (Dec., 1947). In an article in the *American Anthropologist*, **45**, No. 1 (Jan.–March, 1943), Dr. Weidenreich once again affirms his belief that Neanderthal man was the ancestor of *Homo sapiens*. The majority of physical anthropologists will probably not agree with the theories set forth in "The Neanderthal Man and the ancestors of *Homo sapiens*", but nevertheless Dr. Weidenreich can never be ignored with impunity. The last article comes from the *Transactions of the New York Academy of Sciences*, Series II, **4**, No. 1 (Nov., 1941). It is a lecture on the site and technique of excavation of fossil man in Choukoutien, China. No anatomical details of the finds are given; but the student will find conveniently set out the story of the discovery and the excavation.

The Sondes Place Research Institute

THE Sondes Place Research Institute, Dorking, Surrey, of MacTaggart and Evans, Ltd., industrial consultants, is described briefly in an illustrated booklet which this firm has issued. There are fifteen laboratories, besides offices, stores, dark room, library and semi-scale building and workshops. The Analytical Laboratory and the Physical Testing and Cement Laboratories are service laboratories carrying out analysis and testing for the rest of the organisation and to some extent for clients. The Spectroscopy and Microscopy Laboratories and the dark room, as well as the X-ray Analysis Laboratory, function both as service departments and as research laboratories, but the main chemical laboratory is used exclusively for research and development. The Physical Laboratory is used mainly for physico-chemical research and for determining physical constants, while the Electronics Laboratory deals with the application of electronic methods and servo-mechanisms to industry. Work is carried out either for a fixed fee, on a time basis, or for a monthly or yearly retainer; during the past few years problems relating to abrasives, adhesives, bricks, cast iron, cement and concrete, detergents, fibre boards, gelatine and glue, gypsum, lime, linoleum substitute, mineral oils, paint, plastics, printing, synthetic organic chemicals, strip steel, etc., have been handled.

Applications of Electronics to Research and Industry

A SYMPOSIUM on the applications of electronics to research and industry is being arranged by the Electronics Section of the Scientific Instrument Manufacturers' Association, to be held in the Caxton Hall, Westminster, S.W.1, during November 18 and 19. The subjects for discussion are: measurement of displacement by electronic methods; frequency measurement; electronics in computing; measurement of ionizing radiation; high-vacuum gauges; the *radio sonde* and its applications; industrial applications of ultrasonics; metal detection; electronic control of batching; electronics in spectroscopy and spectrophotometry; dynamic recording of mechanical strains; and picture telegraphy. There will be an exhibition of British electronic instruments in the Caxton Hall during the period of the meeting. Particulars and tickets of admission can be obtained on application to the Secretary.

Conference on Dust in Industry

THE Society of Chemical Industry is arranging a Conference on Dust in Industry, which will be held in the University of Leeds during September 28–30. The papers are being arranged in four groups, dealing with physical characteristics and estimation of dust (chairman, Prof. H. V. A. Briscoe), practical aspects of the dust problem (chairmen, Mr. Julian M. Leonard and Mr. A. V. Hussey), fire and explosion hazards (Sir Reginald Thomas), and health hazards (Prof. E. C. Dodds). Further particulars can be obtained from the General Secretary of the Society, 56 Victoria Street, London, S.W.1.

Colonial Services Appointments

THE following appointments in the Colonial Services have been announced: R. B. Symington, agricultural officer, Northern Rhodesia; F. W. Champion, assistant conservator of forests, Tanganyika; P. A. Daley, assistant conservator of forests, Nigeria; D. G. Ellis, assistant conservator of forests, Nigeria; M. Gane, assistant conservator of forests, Tanganyika; G. S. MacPherson, assistant conservator of forests, Gold Coast; H. Sanders, assistant conservator of forests, Nigeria; J. R. T. Hazell, geologist, Nigeria; C. V. Cutting, analytical chemist, Tung Experimental Station, Nyasaland; D. A. Donald (agricultural officer, Fiji), senior agricultural officer, British Solomon Islands Protectorate; T. G. Strangeways (agricultural officer, Northern Rhodesia), senior agricultural officer, Hong Kong; W. O. Sunman (assistant to the Director of Agriculture, Kenya), assistant director of agriculture, Kenya; G. W. Chapman (assistant conservator of forests, Cyprus), senior assistant conservator of forests, Cyprus; N. Harris (geologist, Uganda), senior geologist, Uganda; W. G. Beaton (deputy director of veterinary services, Nigeria), director of veterinary services, Nigeria.

The Night Sky in October

NEW moon occurs on Oct. 2d. 19h. 42m., U.T., and full moon on Oct. 18d. 02h. 23m. The following conjunctions with the moon take place: Oct. 4d. 11h., Mercury 4° S.; Oct. 5d. 18h., Mars 1° N.; Oct. 8d. 02h., Jupiter 4° N.; Oct. 27d. 17h., Saturn 4° S.; Oct. 29d. 07h., Venus 2° S.; Oct. 31d. 00h., Mercury 0·5° N. In addition to these conjunctions with the moon, Venus is in conjunction with Regulus on Oct. 5d. 21h., Venus 0·4° S., and on Oct. 8d. 20h. Venus is in conjunction with Saturn, Venus 1·1° S. Mercury, in inferior conjunction on Oct. 20 and stationary on Oct. 28, is unfavourably placed for observation during the greater portion of the month. On Oct. 31 the planet rises 1h. 40m. before the sun and can be seen in the eastern sky. Venus rises at 2h., 2h. 40m. and 3h. 15m. at the beginning, middle and end of the month, respectively, and can be seen in the morning hours, stellar magnitude −3·6, the visible illuminated portion of disk varying between 0·64 and 0·74. Mars sets a little more than an hour after the sun during October and is not well placed for observation. Jupiter sets at 20h. 36m., 19h. 50m. and 18h. 57m. on Oct. 1, 15 and 31, respectively, and is visible in the western sky (stellar magnitude −1·6) for some time after sunset. Saturn rises at 2h. 30m. and 0h. 50m. at the beginning and end of the month, and can be seen in the morning hours, stellar magnitude 0·9. Occultations of stars brighter than magnitude 6 are as follow: Oct. 14d. 21h. 47·8m., ψ^3 Aquar. (*D*); Oct. 21d. 00h. 16·0m., 32 Taur. (*R*); Oct. 25d. 03h. 47·2m., ω Canc. (*R*); *D* and *R* refer to disappearance and reappearance, respectively, and the latitude of Greenwich is assumed. The Orionid meteors are due about October 16–24, but moonlight will partly interfere with observation of this shower.

Announcements

PROF. M. G. EVANS, professor of inorganic and physical chemistry in the University of Leeds, has been appointed to the chair of physical chemistry in the University of Manchester.

MR. W. T. COOPER, for the past five years scientific editor and head of the Publications Department of the British Coal Utilisation Research Association, has been appointed assistant secretary (editorial) of the Institute of Fuel.

THE third Fleming Memorial Lecture of the Television Society will be delivered by Mr. Arthur Blok, who will give some personal recollections of Sir Ambrose Fleming. The Lecture will be given at the Royal Institution, London, W.1, on September 29, at 6.30 p.m.

IT is announced that, owing to lack of funds, the International Office for Nature Protection cannot continue its work in Holland, and Dr. J. H. Westermann has resigned from the post of acting director. Following the decision of the General Council, the Bureau was recently transferred from Heerengracht 540, Amsterdam, to the Royal Natural History Museum, 31 rue Fautier, Brussels, where it will be under the supervision of Prof. V. van Straelen, vice-president of the Office.

TWO courses in photoelasticity are being arranged at University College, London; one will consist of twenty-eight weekly lectures, with periods of laboratory work during the second and third terms of the session; the other, ten periods (lectures and demonstrations). Full particulars can be obtained from Col. H. T. Jessop, Photoelastic Laboratory, University College, London, W.C.1.

ERRATUM.—Referring to the communication entitled "A Simple Result in Quadrature" (*Nature*, August 7, p. 215), Sir K. S. Krishnan states that in the last entry of column 2 of the table, the numerator should read

$$(2\cos\tfrac{1}{2}v)^{\alpha+\beta-2}\exp\{-\tfrac{1}{2}iv(\alpha-\beta)\}.$$

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Lunar Tidal Oscillations in the Ionosphere

USING the well-known radio methods of upper atmospheric exploration, Appleton and Weekes[1] showed that the *E*-layer of the ionosphere is subject to an unexpectedly large lunar tide. The tide was found to be semi-diurnal in character, of the order of 1 km. in amplitude, the maximum heights being reached about $\frac{1}{2}$ hr. before the lunar transits.

More recently Martyn[2] has shown that the ionospheric observations made at the equatorial Huancayo station of the U.S. Department of Terrestrial Magnetism indicate a semi-diurnal lunar tide for the F_2-layer, also of very substantial magnitude, and has shown that this lunar oscillation can be observed in both the heights and critical frequencies of that layer.

Counting the magnitude and phase of the semi-diurnal tides in the *E*-layer as established for the location of south-east England, we have therefore examined F_2-layer ionospheric data for the same location in order to discover whether there is any variation of phase and amplitude with height. It was also considered of interest to find out whether the lunar tide in the F_2-layer could be detected for a station as far removed from the equator as latitude 51$\frac{1}{2}$° N.

As the material for analysis we have used the Slough hourly values of both the F_2-layer critical frequency and also of a quantity, h_m, the height of the maximum ionization level of the F_2-layer. Values of h_m were calculated by a method we have previously described[3]. Semi-diurnal lunar oscillations have been found in the values of both f_{F_2} and h_m. The amplitude of the oscillation in the case of f_{F_2} is about 0·05 Mc./s., the maximum being reached shortly before the time of lunar transit. The amplitude of the oscillations in the case of h_m is about 2 km.; but here the maximum is attained approximately mid-way between lunar transits. Thus the lunar tidal effects in f_{F_2} and in h_m are seen to be approximately out of phase, a result not unexpected from our previous study of F_2-layer phenomena generally. What is unexpected, however, is that the lunar diurnal *height* variations for the F_2-layer are found to be entirely different in phase from those previously observed for the lower level of the *E*-layer, indicating an alteration of phase of lunar height oscillation with change of ionospheric level. An investigation of corresponding effects in h'_{F_2} data, which relate to an intermediate level, indicate a phase maximum at a time intermediate between those found for the *E*-layer and for the level of h_m for the F_2-layer.

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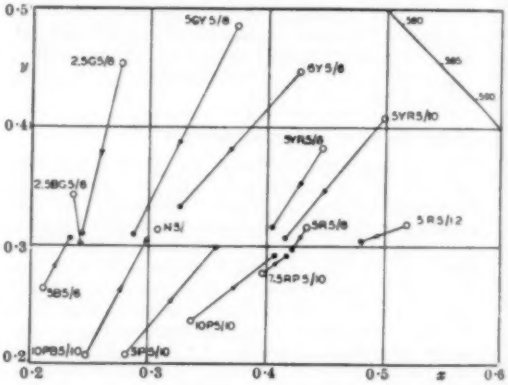
[1] Appleton, E. V., and Weekes, K., *Proc. Roy. Soc.*, **171**, 171 (1939).
[2] Martyn, D. F., *Proc. Roy. Soc.*, **189**, 241, 190, 273 (1947).
[3] Appleton, E. V., and Beynon, W. J. G., *Proc. Phys. Soc.*, **52**, 518 (1940).

Apparent Colours of Surfaces of Small Subtense

THE investigations of Hartridge[1] and others have substantiated the early conclusion of König[2] that the eye behaves as if tritanopic for coloured stimuli of small subtense, and it occurred to me that it would be of both theoretical and practical interest to determine the actual colours assumed under controlled conditions by small coloured surfaces. The first results are so striking a confirmation of König's conclusions that they are presented here as a preliminary report.

Small circular patches of a number of Munsell colours chosen from the 5-plane were presented against a black background (reflectance 2·6 per cent) singly and in random order to an observer seated at such a distance that they subtended 2 minutes of arc. The observer was provided with a chart having larger samples of all the Munsell colours in the 5-plane, systematically arranged, and a black mask with which any one colour could be isolated. The sample and the comparison chart were separately illuminated by 180 lumens m.$^{-2}$ of artificial daylight similar in colour to C.I.E. source '*C*'. The observer was encouraged to be critical and to interpolate between the even values of chroma available; there was no possibility of interpolating between hues.



The figure is a portion of the C.I.E. mixture diagram showing the co-ordinates of the sample colours by open circles, and the mean location of the apparent colours at 2′ subtense by black dots. The (Munsell) neutral point is also indicated. Eight sets of observations by one observer are represented in the means.

Three main results will be noted: (1) the apparent displacements are in general directed towards or away from the short wave-length extremity of the spectrum locus ($x = 0{\cdot}17$, $y = 0{\cdot}01$); (2) the apparent colours lie closely about a line which if produced would cut the spectrum locus at about 491 and 630 mμ; (3) blue, green and blue-green are confused, as are also purple, red-purple, and orange; (4) yellowish-green, grey and purplish-blue are confused. The last two items, and indeed the entire picture, are in full accord with König's description of tritanopia. As an independent check of item (4), the Munsell colours lying near the straight line joining 5GY5/8 and 10PB5/10 were mounted side by side in order on the same piece of black card. At the experimental distance they appeared very nearly identical; though the extreme

[1] Hartridge, H., *Proc. Roy. Soc.*, **B 131**, 200 (1942).
[2] König, A., *Sitzungsber. Akad. Wiss. Berlin*, 241 (1897).

colours were just distinguishable. The three colours 2.5G5/8, 2.5BG5/6 and 5B5/6, similarly mounted, appeared identical.

A second observer, completely unacquainted with the Munsell colour system, obtained results similar to those shown in the figure, though with more scatter. Apparatus is being constructed to check these findings by methods less open to objection on psychophysical grounds; but of the general picture there seems no doubt.

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National Research Council,
Ottawa. April 13.

[1] Hartridge, H., *Phil. Trans.*, B, 592, 519 (1947).
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Electronic Digital Computers

A small electronic digital computing machine has been operating successfully for some weeks in the Royal Society Computing Machine Laboratory, which is at present housed in the Electrical Engineering Department of the University of Manchester. The machine is purely experimental, and is on too small a scale to be of mathematical value. It was built primarily to test the soundness of the storage principle employed and to permit experience to be gained with this type of machine before embarking on the design of a full-size machine. However, apart from its small size, the machine is, in principle, 'universal' in the sense that it can be used to solve any problem that can be reduced to a programme of elementary instructions; the programme can be changed without any mechanical or electro-mechanical circuit changes.

The essential parts of such a machine are: (1) a store for information and orders; (2) various arithmetical organs (for example, adders, multipliers); (3) a control unit[1].

The present machine contains the minimum set of facilities for a universal machine, namely: (*a*) If x is any number in the store, $-x$ can be written into a central 'accumulator' A; or x can be subtracted from what is in A. (*b*) The number A can be written in an assigned address in the store. (By means of (*a*) and (*b*) addition or direct writing into A can be programmed.) (*c*) The content of A can be tested for whether $x \geqslant 0$, or $x < 0$; if $x < 0$ the order standing next in the store is passed over. This gives the essential power of branching routines. (*d*) Control can be shifted to an assigned order in the table. (*e*) The machine can be ordered to stop.

The capacity of the store is at present only 32 'words', each of 31 binary digits, to hold instructions, data and working. Hence only simple arithmetic routines devised to test the machine can be run. Examples of problems that have been carried out are: (1) Long division by the standard process. (For $(2^{30} - 1)/31$, this took $1\frac{1}{2}$ seconds, the quotient being given to 39 significant binary figures of which the 13 least significant, to the left of the binary point, were zero, since 31 is a factor of $2^{30} - 1$.) (2) H.C.F. by the standard process. (For 314,159,265 and 271,828,183, which are co-prime, approximately 0·5 second.) (3) Factorizing an integer. For (3) the method was deliberately chosen to give a long run the result of which could be easily checked. Thus the highest proper factor of 2^{18} was found by trying in a single routine every integer from $2^{18} - 1$ downward, the necessary divisions being done not by long division, but by the primitive process of repeated subtraction of the divisor. Thus about 130,000 numbers were tested, involving some 3·5 million operations. The correct answer was obtained in a 52-minute run. The instruction table in the machine contained 17 entries.

It will, of course, be understood that it is intended to have other arithmetical facilities, as well as a much larger store, in a full-sized machine; and that even on the present machine quicker routines could have been used. At present routines are chosen with the sole object of testing the machine as thoroughly as possible.

The development of this machine has been very actively supported by the Telecommunications Research Establishment, Great Malvern.

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[1] For a fuller discussion see, for example, the Royal Society discussion on computing machines, summary in *Nature*, 161, 712 (1948).

Excitation Probability Functions of Atomic and Molecular Energy-Levels

In the correlation of the electrical and spectroscopic properties of a glow discharge in a molecular or atomic gas, the need for a rough quantitative analysis of the kinetics of the excitation of the gas soon becomes apparent. In all but the simplest cases, no more than a rough analysis can be attempted with the present scanty experimental and theoretical knowledge of the interaction of slow electrons with atoms and molecules. It is the purpose of this communication to present an empirical form for the excitation probability functions of the atomic and molecular levels which seems to fit the few experimental curves fairly closely, and at least provides a basis for calculation where previously only generalized discussion was possible.

In principle, the excitation probability functions of atomic or molecular levels may be calculated from quantum mechanics. However, in actual fact, very few atoms and molecules have been considered[1]. In any event, serious theoretical difficulties exist in calculating the excitation probabilities for collisions with slow electrons—the interesting case from the point of view of glow discharge—where the Born approximation becomes invalid. Apart from these difficulties, it is necessary that the wave functions of the ground and excited states should be known. The wave functions of very few of the energy states of atoms and molecules have, in fact, been calculated. The quantum-mechanical method does not express the excitation probability function in a form which is readily applicable to discharge problems. Blackett[2] made an interesting semi-classical approach to the subject using the principles of conservation of energy and momentum. This, however, was limited and exploratory.

The shapes of excitation functions observed experimentally for singlet and triplet atomic levels from a singlet ground state are different[3]. The singlet excitation function rises from zero at the energy of the level concerned to a broad maximum somewhat above it, while the triplet excitation function rises from zero at the energy of the level concerned to a

sharp maximum much closer to the level. The difference in shape is due to electron exchange being necessary for change of multiplicity.

An examination of the general shape of the experimental excitation functions suggests that they may be represented by:

$$s_1(V) = C(V - E_{AB})^{1/2} \exp\,[-L(V - E_{AB})], \quad (1)$$

where $s_1(V)$ is the excitation probability as a function of the energy V of the exciting electrons; E_{AB} is the energy separation of the ground (A) and the excited (B) states; L, an adjustable constant, controls the position and shape of the maximum (s_{max} occurs at $V = \frac{1}{2L}$); C is a scaling constant. Such a function has been fitted to the experimental curves for singlet and triplet excitation of atoms. The fit is comparable to that of the theoretical curves in cases where they have been calculated.

If (1) represents the excitation probability function for a first-kind collision between an atom and an electron, it can be applied in the relation of Klein and Rosseland[4], namely:

$$s_2(V - E_{AB}) = \frac{p_A}{p_B}\left[\frac{V}{V - E_{AB}}\right]^{1/2} s_1(V), \quad (2)$$

for the probability of the microscopically reversible case of a second-kind collision between an excited atom and an electron. p_A and p_B are the quantum weights of the states A and B respectively. From (1) and (2) we have:

$$s_2(V - E_{AB}) = C\,\frac{p_A}{p_B}\,V^{1/2} \exp[-L(V - E_{AB})]. \quad (3)$$

(1) and (3) predict the maxima of s_1 and s_2 to fall at energies which are greater by equal amounts than the energies of B and A respectively.

In the case of molecules, both experimental and theoretical knowledge is more scanty than in the case of atoms. The excitation functions of the nitrogen triplet *bands* have been investigated by numerous workers. These excitation functions are not necessarily the excitation functions of the upper levels concerned, however, as this assumes a direct excitation mechanism to these levels, and radiation as the only depopulating mechanism. As has been suggested previously[5], this assumption can by no means always be made, especially in the case of the triplet bands.

The excitations of both atomic lines and molecular band-systems are similar in that the orbital electrons in each case are the governing factor. We may therefore suppose the general shape of the excitation functions for molecular electronic levels to be the same as for atomic levels, and seek to apply the empirical function suggested above. In the molecular case, unfortunately, there are less experimental data of excitation functions (for molecular *levels*) to which the empirical equation may be fitted. Consequently, calculations must be of a more general nature than in the case of atoms. Study of the curves represented by (1) show that in cases where the experimental excitation functions are unknown, choice of $L \sim 1$ for triplet excitation functions and $L \sim 0{\cdot}1$ for singlet excitation functions enables first approximation analytical progress to be made. The postulation of a function such as (1) is necessary if any quantitative calculation is to be attempted on the excitation mechanisms in a molecular gas, when excited by electrons of an energy distribution $n(V)dV$, as exists, for example, in glow discharge. Such an analysis has been made of the excitation kinetics of nitrogen, the results of which are to be published shortly.

The choice of the suggested function has no theoretical basis. Its justification is in its fitting the experimental curves and of being of convenient analytical form. It enables some progress to be made in correlating electrical and spectroscopic data from discharge, in connexion with which this work has been done.

I should like to express my thanks to Prof. R. W. B. Pearse for valuable discussion.

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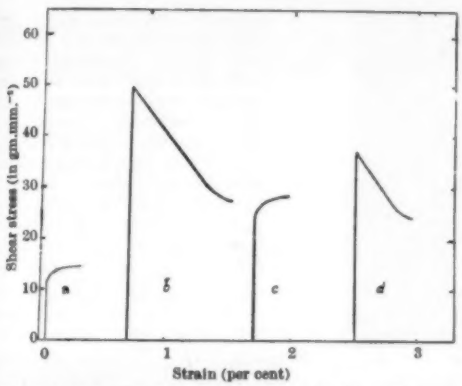
[1] Mott and Massey, "Theory of Atomic Collisions", Chapters 11, 12. Massey and Mohr, *Proc. Roy. Soc.*, A, **132**, 605 (1931); **140**, 613 (1933). Penney, *Phys. Rev.*, **39**, 472 (1932).
[2] Blackett, *Proc. Camb. Phil. Soc.*, **22**, 56 (1924).
[3] Lees and Skinner, *Nature*, **123**, 836 (1929); *Proc. Roy. Soc.*, A, **137**, 173 (1932).
[4] Klein and Rosseland, *Z. Phys.*, **4**, 46 (1921).
[5] Nicholls, *Nature* [**162**, 231 (1948)].

Thermal Hardening of Cadmium Crystals

By annealing a crystal of chemically pure zinc in the temperature range 0–300° C. after a small plastic extension (~1 per cent) had been given, Orowan[1,2] found that the crystal could be made resistant to plastic deformation until a yield stress much higher than the previously determined 'normal' value was reached. The crystal would then suddenly yield and continue to extend plastically at the normal lower yield stress. On the other hand, a freshly strained crystal began to flow when retested as soon as the lower yield stress was reached. He termed the effect 'thermal hardening'. These effects remind one strongly of the yield phenomenon and strain ageing of iron, and the terms 'upper' and 'lower yield points', respectively, are suggested for the yield values belonging to the thermally hardened and freshly strained states.

Thermal hardening has been observed more recently by Smith[3] in spectroscopically pure cadmium crystals; however, whereas Orowan found the effect to be rare in zinc, Smith obtained it with every cadmium crystal he examined. We have found that cadmium crystals grown (by Andrade and Roscoe's fusion method[4]) in an atmosphere of pure argon give no sign of the effect; but marked thermal hardening could be produced consistently whenever the crystals were grown in nitrogen. It was also produced when argon contaminated by small amounts of nitrogen was used. Curve *a* shows a stress-strain curve from a crystal grown in pure argon and given a treatment designed to develop thermal hardening. The yield phenomenon, which is quite absent in this case, is clearly produced in a similarly treated crystal which has been grown in nitrogen (curve *b*); this second crystal produces the 'normal' type of curve, however, in which the yield phenomenon is absent, when it is tested in the freshly strained state (curve *c*).

Smith found that the value of the upper yield point varied markedly with λ, the angle between the axis of the applied tensile load and the glide direction, and a minimum was obtained in the range $\lambda = 40$–$45°$, where the upper yield point was only 5 per cent higher than the lower yield point. We have so far



Stress-strain curves of cadmium crystals. (*a*) Grown in argon; pre-strained 0·8 per cent; 40 min. at 200° C.; $\chi = 19°$, $\lambda = 30°$. (*b*) Grown in nitrogen; pre-strained 0·98 per cent; 50 min. at 200° C.; $\chi = 28°$, $\lambda = 40°$. (*c*) Immediately retested after (*b*). (*d*) Grown in nitrogen: no pre-strain; 90 min. at 200° C.; $\chi = \lambda = 56°$. (χ = angle between slip plane and tension axis. λ = angle between slip direction and tension axis)

failed to confirm this result; thus we have observed a difference of 70–80 per cent in the yield-points on crystals with $\lambda \sim 40°$, which is as high as can be obtained in other ranges of λ.

A difference between thermal hardening and the yield phenomenon in iron is that the characteristic yield point is produced at the first time of testing with iron, whereas with a cadmium crystal the first curve is of the type of curve *c* and the yield point type of curve is not obtained until a thermal hardening treatment has been given. The difference may be due to handling a soft crystal. To confirm this, a cadmium crystal was mounted in the testing machine and annealed *in situ* before testing. The characteristic upper yield point was developed by this treatment (curve *d*), which shows that the preliminary straining treatment is not essential and that the difference mentioned above between thermal hardening and the yielding of iron is trivial.

A subsidiary effect noticed is that, with successive annealing treatments, both the upper and lower yield points rise above their previously determined values (see table). This was found to be due to the formation of a surface film on the cadmium crystals during annealing. Roscoe[8] has shown that the presence of a thin oxide film can raise the critical shear stress of cadmium, and we have confirmed this on cadmium crystals free from nitrogen; a critical shear stress of 12 gm.mm.$^{-2}$ was obtained when the crystal surface was clean and, by a light oxidation treatment, this could be raised to 30 gm.mm.$^{-2}$.

Effect of successive annealing treatments on the yield points of a cadmium crystal ($\chi = \lambda = 56°$)

Treatment	Upper yield point, τ_1, measured as resolved shear stress in gm.mm.$^{-2}$	Lower yield point, τ_2, measured as resolved shear stress in gm.mm.$^{-2}$	$\frac{\tau_1 - \tau_2}{\tau_2} \times 100\%$
As grown	—	17·1	—
70 min. at 200° C.	33·4	20·2	65
Further 33 min. at 200° C.	32·8	20·6	59
Further 90 min. at 200° C.	41·0	21·8	88
Further 35 min. at 200° C.	42·8	23·3	83·5

A further similarity between thermal hardening and the yield phenomenon of iron is that nitrogen produces thermal hardening in cadmium, and the presence of small amounts of carbon or nitrogen in iron is associated with the yield phenomenon[6–8]. An explanation of the effects in iron, put forward recently by one of us[9], may thus be also applied to thermal hardening. It is considered that foreign atoms in solid solution migrate to dislocations, where they relieve stresses by altering locally the equilibrium lattice constants. A large force is then required to tear a dislocation from its cloud of solute atoms (upper yield point), and when a dislocation has in this way been freed it can migrate rapidly through the lattice under a smaller force (lower yield point). A freshly strained crystal contains free dislocations and shows no upper yield point; but, on annealing, the solute atoms can migrate to the free dislocations, anchoring them once more and causing the yield phenomenon to return.

We wish to thank Dr. C. L. Smith for helpful discussions, and Prof. D. Hanson and the Department of Scientific and Industrial Research for their interest and for providing facilities for this investigation.

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[2] Orowan, E., *Proc. Phys. Soc.*, **52**, 14 (1940).
[3] Smith, C. L., *Nature*, **160**, 466 (1947).
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[5] Roscoe, R., *Phil. Mag.*, **21**, 399 (1936).
[6] Edwards, C. A., Phillips, D. L., and Jones, H. N., *J. Iron and Steel Inst.*, **142**, 199 (1940).
[7] Snoek, J. L., *Physica*, **8**, 734 (1941).
[8] Low, J. R., and Gensamer, M., *Trans. Amer. Inst. Min. Met. Eng.*, **158**, 207 (1944).
[9] Cottrell, A. H., Report of Bristol Conf., Phys. Soc., 30 (1948).

Limiting Diffusion Currents at Wire Electrodes

The limiting current for an electrode reaction in aqueous solution, in which diffusion of the depolarizer to the electrode surface is the rate-determining factor, is generally treated[1] by assuming there to be present adjacent to the surface a diffusion layer of fixed thickness across which a linear concentration gradient is set up. On these assumptions, the limiting current is given by the expression:

$$I = \frac{ADnFC}{\delta} \times 10^{-3}, \qquad (1)$$

where I is the limiting current (amp.), A the area of the electrode surface (cm.^{2}), D the diffusion coefficient of the depolarizing ion (cm.^{2} sec.$^{-1}$), n the number of electrons involved in the electrode reaction, F the faraday, C the bulk concentration of the depolarizer (gm. ion per litre), and δ the thickness of the diffusion layer (cm.). This expression is found to hold satisfactorily for large electrodes, and δ has a substantially constant value for different depolarizers in unstirred solutions at constant temperature. The same relation has generally been considered to hold for wire electrodes, and since such electrodes are very convenient in practice and give well-defined limiting currents, they have been much used in voltammetric work.

During an investigation of the electrolytic oxidation of potassium ferrocyanide using small vertical wire anodes of constant diameter in unstirred solutions, we found that while the ratio I/AC was satisfactorily constant over a very wide variety of conditions, as required by equation (1), its actual value of *c.* 5×10^{-2} (at 20° C.) was very much higher than that

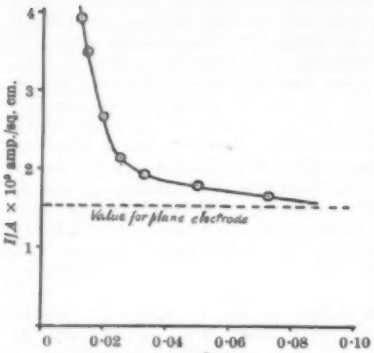

Fig. 1

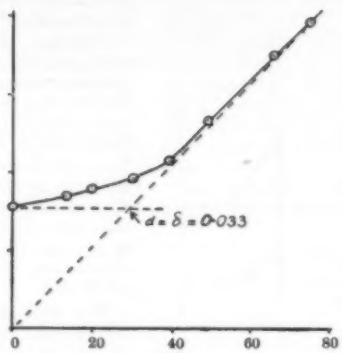

Fig. 2

of $2{\cdot}9 \times 10^{-2}$ (at 25° C.) found by Kolthoff and Laitinen[2] for the same system. In attempting to resolve this discrepancy, it was noted that these workers had used rather thicker wire electrodes than those employed in our investigation, and we have therefore made measurements with wire anodes of different diameters.

We have now found that the ratio I/AC increases rapidly with decreasing diameter when the wire becomes sufficiently thin. Some typical results are shown in Fig. 1 in which the limiting current density in amp./sq. cm. for the anodic oxidation of 0·05*M* potassium ferrocyanide in phosphate buffer at 20° C. is plotted against the diameter d of the wire used. It may be noted that with the thickest wire used of diameter 0·0725 cm., the limiting current density is only slightly higher than that found for a plane electrode, but with decreasing diameter it increases, and below a diameter of 0·04 cm. the increase is very rapid indeed. In Fig. 2 the limiting current density is plotted against the reciprocal of the diameter, and it is seen that for very thin wires it becomes inversely proportional to the diameter; and it appears that:

$$I = \frac{ADnFC}{d} \times 10^{-6}. \qquad (2)$$

The intersection of the dotted lines representing the limiting cases (1) and (2) gives a value of δ of 0·033 cm. Other determinations of δ involve a knowledge of the diffusion coefficient of the depolarizing ion, about which there is usually considerable uncertainty. Early work[1] suggested a value of δ of about 0·05 cm., but Kolthoff and Laitinen[2] from a study of a number of reactions arrived at a value of 0·025 cm. Re-examination of their results, however, shows that their limiting current densities would be about 1·2 times the values for plane electrodes, owing to the diameter effect now reported; and if allowance is made for this, their results give a value of δ of 0·03 cm. (at 25° C.), which is in close agreement with that of 0·033 cm. (at 20° C.) obtained above.

The effect now reported appears to be a general one independent of the nature and concentration of the depolarizer used. In general, it is obvious that when the diameter of the wire approaches the thickness of the diffusion layer, equation (1) must fail, and indeed the diffusion must be of a cylindrical rather than a linear type. We have attempted to account for the experimental results by using the general equation for cylindrical diffusion (which does not of itself lead to any stationary state such as is experimentally observed) and inserting arbitrary boundary conditions; but these attempts have not led to any practically useful result. Empirically, a close fit to the experimental points can be obtained if equation (1) is formally retained and the diameter of the wire d replaced by $\sqrt{d^2 + \delta^2}$ in calculating the electrode area, and this may have some practical value for calculation purposes, although its physical significance is obscure.

The present results have two practical implications. First, in comparing results of limiting current measurements at wire electrodes, as is often done, the wires used must be fairly thick, or of the same diameter, or a correction factor must be introduced. Secondly, in designing electrodes to obtain very high limiting currents, as, for example, the platinum gauze electrodes used in electro-analysis, there is an obvious advantage in using the thinnest possible wire consistent with mechanical strength; our measurements show that the limiting current per unit length of wire becomes independent of diameter for very thin wires, and hence some saving of metal may be achieved by this procedure.

We are indebted to Mr. T. B. Grimley for much helpful discussion.

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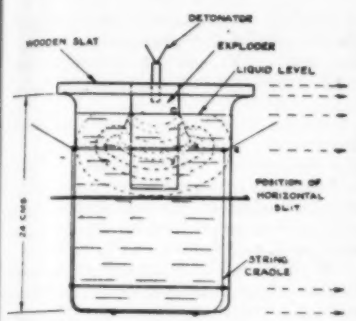
[1] See Glasstone and Hickling, "Electrolytic Oxidation and Reduction", chapter 3 (1935); Kolthoff and Lingane, "Polarography", chapter 32 (1941).
[2] *J. Phys. Chem.*, **45**, 1062 (1941); *J. Amer. Chem. Soc.*, **61**, 3344 (1939).

Detonation in Liquid Explosives

During the War a general investigation was commenced at the Road Research Laboratory, on the initiative of Dr. A. H. Davis, into the process of detonation in explosives, the programme including a photographic study of the detonation waves in transparent liquid explosives—the sensitivity of some of which can be varied by adjusting the constitution—and their relation to primers of different types and shapes. In the work, use was made of a new high-speed mirror camera to photograph the progress of the luminous detonation front inside transparent liquid explosives. A unique feature of the camera was the employment of two independent lens assemblies, each consisting of a telephoto field component focusing on to a spectrographic slit. The slits themselves were focused, via a four-sided rotating mirror, on to a photographic film located in cylindrical guides. The fields of the two slits were arranged to intersect at right angles in the object plane, approximately 30 ft. from the camera. Further, by means of a suitable arrangement of plane mirrors between the rear lenses and the film, images from the two slits were arranged to record on different areas



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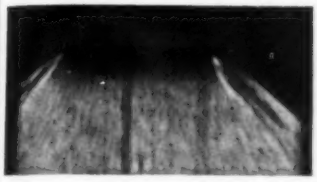

TIME 97 CM/MILLISECOND

RECORD FOR HORIZONTAL SLIT

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of the same film. Use was made in this connexion of adjacent sides of the mirror block. In this manner it was possible to record simultaneously in two directions at right angles. The maximum recording speed was approximately 100 cm. per sec., with a time resolution of 1 microsecond.

A record obtained during the detonation of a 14-lb. charge of the transparent liquid explosive diglycol dinitrate, using a 12-oz. cylindrical tetryl primer, is reproduced herewith. The vertical slit was focused on the axis of the glass beaker used to contain the explosive, while the horizontal slit covered a section slightly below the bottom of the primer. To facilitate interpretation, the sketch of the charge is reproduced to the same linear scale as the records.

Referring to the record from the vertical slit, the flash from the detonator occurs first in time, followed by extensive luminosity from the section of the primer between the underside of the primer support and the level of the liquid. The flame front from this zone, travelling towards the camera, is later deflected upwards by the glass wall of the beaker. The boundary *CYB* on the record indicates the passage of the detonation front, first down the side of the primer and afterwards, with a slight decrease in velocity, down the axis of the beaker. During its passage from *e* to *y* along the primer, the detonation front has spread, to a limited extent only, into the liquid explosive, as sketched on the diagram. This encroachment is indicated by the boundary *CK* on the record.

On a circle concentric with the charge axis, and passing through the point *k*, a new detonation process has originated in the liquid. This has combined with the original wave to form a front of the shape sketched. The upward movement of this front is recorded as the boundary *KH*. When the detonation wave reaches the glass at *e*, luminosity ceases for a few microseconds, before the commencement of burning in air. This corresponds to point *E* on the record. As the expanding front shatters the glass, the boundary *FEG* is developed. From a mathematical analysis of this boundary the shape of the detonation wave can be derived. (The tail *NB* is due partly to reflexion from the convex base of the beaker, and partly to refraction at the curve in which the wall of the beaker meets the base.)

The horizontal slit records nothing until the detonation front in the liquid crosses its field. The curved boundary again gives a key to the shape of the wave, but in this case a correction must be made for refraction in the undetonated liquid. The record as it stands gives the impression that the detonation front has been temporarily contained by the glass!

Using this technique the critical primer/charge diameter ratio necessary to give complete detonation was investigated, and the effect of shaping the primer examined. The horizontal slit was found to be invaluable in the elucidation of the more complex detonation processes associated with shaped primers.

Some of the records obtained suggested that diglycol dinitrate has one or more low orders of detonation of the kind referred to recently by Jones and Mitchell[1]. Unfortunately, the luminosity associated with them was insufficient to record on the fastest film available, and the detonation process had to be reconstructed from the envelope of the after-burning, which was generally sufficiently luminous to record.

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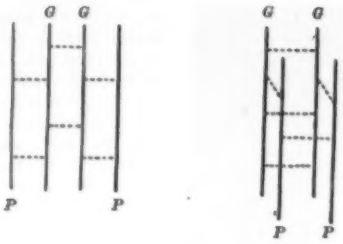
May 24.

[1] Jones, E., and Mitchell, D., *Nature*, **161**, 98 (1948).

Some Peptides from Insulin

By oxidation with performic acid, the insulin molecule can be split into its separate polypeptide chains[1]. It has now been possible to prepare two fractions from the oxidized insulin: fraction *A* contains only glycine terminal residues and no arginine, histidine, lysine, phenylalanine or threonine; fraction *B* contains 97 per cent phenylalanine terminal residues and all the amino-acids that are present in insulin. The yield of fraction *A* is more than 25 per cent of the original insulin, indicating that it represents more than one of the peptide chains of the insulin. The yield of fraction *B* is rather less.

The sulphur contents of the two fractions were kindly determined by Mr. M. W. Rees, who found



that fraction *A* contains four cysteic acid residues per molecule of molecular weight 2,900, and fraction *B* contains two per molecule of molecular weight 4,100. From these results it is possible to formulate a number of possible structures for the insulin submolecule. Thus, if we assume that it can be regarded as four parallel peptide chains, then only two structures are possible, as shown in the accompanying diagram, where the full lines represent the peptide chains and the broken lines the —S—S— bridges. The chains marked *G* have glycine terminal residues and those marked *P* phenylalanine terminal residues. It is assumed that the two glycyl chains have equal cysteic acid contents, which is probable from their similar properties. Other structures are possible if the chains cannot be regarded as parallel.

In order to carry further the investigation of the structure of these peptides, the products of the partial hydrolysis of their 2 : 4-dinitrophenyl-derivatives were studied. Using this method, it is possible to separate from a complex partial hydrolysate a relatively simple mixture of dinitrophenyl-peptides originating from the terminal peptides of the molecule. The isolation of a number of such peptides from an enzymic digest of insulin has already been reported by Woolley[2]. In the present work, acid hydrolysis has been used and the dinitrophenyl-peptides fractionated by partition chromatography on silica gel. The order of the amino-acids in them was determined by subsequent partial hydrolysis.

In a preliminary experiment with horse globin, the following peptides were isolated in a crystalline form and their structure determined: *H*1, 2 : 4-dinitrophenyl-valyl-leucine; *H*2, 2 : 4-dinitrophenyl-valyl-glutamyl-leucine; *H*3, the amide of *H*2.

This demonstrates that the six open peptide chains of horse globin[3] are not identical but consist of at least two different types, one with the terminal peptide valyl-leucine and one with the terminal peptide valyl-glutaminyl-leucine.

The method was then applied to the above fractions of oxidized insulin. From a partial hydrolysate of the dinitrophenyl-derivative of fraction *A* the following peptides were separated: *A*1, 2 : 4-dinitrophenyl-glycyl-isoleucine; *A*2, 2 : 4-dinitrophenyl-glycyl-isoleucyl-valine; *A*3, 2 : 4-dinitrophenyl-glycyl-isoleucyl-valyl-glutamic acid; *A*4, the peptide containing glutamic acid, leucine, serine and O-2 : 4-dinitrophenyl-tyrosine, which has been reported by Woolley[2]. Its structure has not yet been determined.

Fraction *A* thus consists of at least two separate chains with different terminal peptides. It is interesting to note that these chains, though not identical, are very similar in that they have no basic amino-acids, threonine or phenylalanine, are not easily separated from one another and have the same molecular weight and electrophoretic mobility.

Using fraction *B* the following peptides were detected: *B*1, 2 : 4-dinitrophenyl-phenylalanyl-valine; *B*2, 2 : 4-dinitrophenyl-phenylalanyl-valyl-aspartic acid; *B*3, 2 : 4-dinitrophenyl-phenylalanyl-valyl-aspartyl-glutamic acid; *B*4, ε-2 : 4-dinitrophenyl-lysyl-alanine; *B*5, threonyl-(ε-2 : 4-dinitrophenyl)-lysyl-alanine.

No evidence has yet been obtained of a second chain in this fraction.

The method of determining the structure of these peptides can be illustrated by considering the peptide *A*3. Using quantitative paper chromatography[4], it was shown that there was one molecule of isoleucine, valine and glutamic acid per molecule of 2 : 4-dinitrophenyl-glycine. While no great accuracy is claimed for this method as used here, it is sufficient to indicate without any doubt the number of residues present. On further partial hydrolysis of peptide *A*3, the peptides *A*1 and *A*2 and 2 : 4-dinitrophenyl-glycine were produced. From the composition of these peptides the order of the amino-acids could then be deduced, and it was confirmed by the identification of isoleucyl-valine in partial hydrolysate of peptide *A*2, by the method of Consden, Gordon and Martin[5].

In addition to peptide *A*4, Woolley has isolated from insulin a number of 2 : 4-dinitrophenyl-glycyl peptides in which threonine occurred not far from the terminal residue. We have not yet found evidence of these peptides in the present work in any of the main fractions of oxidized insulin; but it may be that they are not extracted under the procedure employed. It is possible, therefore, that there may be at least three different glycyl chains in insulin, though it is difficult to reconcile this with the present picture of the structure of insulin.

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May 24.

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[2] Woolley, D. W., *Federation Proc.*, **7**, 200 (1948).
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[4] Polson, A., Mosley, V. M., and Wyckoff, R. W. G., *Science*, **105**, 603 (1947).
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"17-Ketosteroid II" Isolated from Urine; its Reaction with Hydrochloric Acid

In an earlier communication[1] we announced the isolation of a new 17-ketosteroid in the urine of a girl with adenoma of the adrenal cortex. This compound, which we designated "17-ketosteroid II", is converted in presence of HCl into a mixture of $C_{19}H_{27}OCl$ and dehydro-*iso*-androsterone. We have now studied this reaction in more detail.

In the first place we were able to prove that the compound $C_{19}H_{29}OCl$ is identical with the 3-chloro-Δ^5-androstenone-17 isolated by Butenandt and Dannenbaum[2] from human male urine. This compound can be synthesized by the method of Wallis and Fernholz[3] by the action of phosphorus pentachloride on dehydro-*iso*-androsterone. We purified the product thus obtained by means of chromatographic analysis. The melting point was 153·5–155·5° C. (corr.).

We then added 5 per cent aqueous hydrochloric acid to a solution of pure 17-ketosteroid II in ethanol; under these conditions the latter reacts immediately even at room temperature. The reaction mixture consists of about 80 per cent of $C_{19}H_{27}OCl$

with 20 per cent of dehydro-*iso*-androsterone. The chloroketone prepared from 17-ketosteroid II had m.p. 153·5–155·5° C. The mixed melting point with synthetic 3-chloro-Δ^5-androstenone-17 showed no depression.

In view of the great readiness with which 17-ketosteroid II reacts with hydrochloric acid to form 3-chloro-Δ^5-androstenone-17 (unlike dehydro-*iso*-androsterone), we assume that the 3-chloro-Δ^5-androstenone-17 found in urine has been formed from 17-ketosteroid II and *not* from dehydro-*iso*-androsterone (though 17-ketosteroid II occurs in normal urine in small quantities only). Although everywhere in the literature it is assumed that the chloroketone is formed from dehydro-*iso*-androsterone, Butenandt and co-workers[2] in their original publication did actually point to the possibility of a different precursor.

When 17-ketosteroid II is subjected to the action of hydrochloric acid at 100° C., the product is chiefly dehydro-*iso*-androsterone. When hydrochloric acid is allowed to act for 10 min. on 3-chloro-Δ^5-androstenone-17 (at 100°) the reaction mixture contains about 65 per cent of dehydro-*iso*-androsterone, the remainder being unchanged 3-chloro-Δ^5-androstenone-17. The identity of the dehydro-*iso*-androsterone was proved by means of the mixed melting point with an authentic sample of dehydro-*iso*-androsterone, 140–141° C. (corr.), and the mixed melting point of the corresponding acetates, 170–171° C. (corr.).

These facts lead us to the conclusion that the dehydro-*iso*-androsterone found in relatively large amounts in the urine of patients with carcinoma of the adrenal cortex must be regarded, to some extent at any rate, as an artefact produced by the action of hydrochloric acid on 17-ketosteroid II at the boiling point.

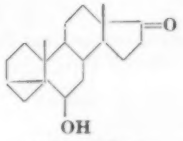
It also appears that the amount of dehydro-*iso*-androsterone thus formed is dependent on the duration of heating with hydrochloric acid. Boiling for 10 min. converts about 65 per cent of the 17-ketosteroid II to dehydro-*iso*-androsterone (see above). If, however, the urine is extracted with an organic solvent before hydrolysis, the 17-ketosteroid II present in the unconjugated form passes into the organic solvent. The result of such a method of extraction is that the amount of dehydro-*iso*-androsterone in the extract is much smaller than when the urine is boiled immediately with acid.

We think it worth while to direct attention to this in connexion with the estimation of dehydro-*iso*-androsterone in urine extracts for clinical purposes.

We have not yet succeeded in ascertaining whether 17-ketosteroid II can also exist in conjugated form in urine. In our previous communication[1] we stated that an acetate of this compound had been prepared (m.p. 109–111° C. (corr.)). Thus it contains an alcoholic hydroxyl group, so that it is by no means impossible that it may also be present in the esterified form in urine. The usual methods of hydrolysis will, however, convert these esters into dehydro-*iso*-androsterone.

Drs. Barton and Klyne (see following letter) kindly sent us a specimen of synthetic *i*-androsten-6-ol-17-one which proved to be identical with our 17-ketosteroid II; an identity that has already been considered in our previous paper. (We are glad to mention here that Dr. Beyerman, working at this Laboratory, suggested this identity for the first time, and we acknowledge with thanks this useful hint.) The identity of the compounds is established by mixed melting points and by identical adsorptive properties in chromatography.

The structure of 17-ketosteroid II is thus completely elucidated.



i-androstenolone

A grant was received for this study from Organon, Ltd., Oss.

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July 12.

[1] *Nature*, **161**, 848 (1948).
[2] *Z. physiol. Chem.*, **229**, 192 (1934).
[3] *J. Amer. Chem. Soc.*, **59**, 765 (1937).

Identification of "17-Ketosteroid II" as *i*-Androsten-6-ol-17-one

Dingemanse, Huis in 't Veld and Hartogh-Katz[1] recently described the isolation from human urine of a compound, "17-ketosteroid II", which they suggested was an androsten-3(α)-ol-17-one. Many of the reactions reported for this substance indicated that it might be *i*-androsten-6-ol-17-one, which has already been obtained by Butenandt and Suranyi[3] from the *p*-toluenesulphonate of dehydro-*iso*-androsterone. We have repeated the preparation of Butenandt and Suranyi, and have confirmed the properties recorded for this substance and for the corresponding diketone obtained on oxidation. The properties of "17-ketosteroid II" and *i*-androstenolone are compared in the accompanying table.

	17-Ketosteroid II	*i*-Androsten-6-ol-17-one
Melting point	140·5–141°	139–140°
$[\alpha]_D$ in alc.	+121°	+122°
Melting point of diketone obtained by oxidation	185°	184–185°

Our *i*-androstenolone showed no depression in melting point on admixture with "17-ketosteroid II" by Dr. Dingemanse, to whom we are most grateful for carrying out this comparison. The agreement in physical and chemical properties between the two compounds, together with this mixed melting point determination, proves that "17-ketosteroid II" and *i*-androsten-6-ol-17-one are identical.

The chloroketone, $C_{19}H_{27}OCl$, m.p. 151–152°, obtained by the Dutch workers by the action of hydrochloric acid on "17-ketosteroid II", must be 3(β)-chloroandrost-5-en-17-one, m.p. 155–157°, first isolated from urinary extracts by Butenandt and Dannenbaum[3].

So far as we are aware, this is the first report of the isolation of an *i*-steroid from urine or from any other natural source. Rosenheim[4] suggested that an *i*-steroid might be the precursor of the chloro-compound mentioned above. That *i*-steroids have

not been detected previously in urine is doubtless due to the fact that the usual method of working up urine for its steroidal content (acid hydrolysis) must lead to the rearrangement of much or all of the δ-steroids contained therein.

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Deodorization of Shark Liver Oil

Shark liver oil, which is one of the cheapest and most plentiful sources of vitamin A in Nature, has a highly disagreeable odour which is very much more pronounced than that of cod liver oil. On account of its unpalatability it does not easily find favour with the consumers. The deodorization of the oil has to be effected in such a manner that the highly susceptible vitamin A is retained intact. Among the various methods that we have tried to achieve this result are: (i) steam-'distillation' of the oil under normal and reduced pressure in which the malodorous substances pass over with the steam; (ii) agitation of the oil with fermenting milk and toddy; and (iii) selective hydrogenation of the oil in the presence of a nickel catalyst.

Steam-treated oils are fairly free from odour when freshly prepared, but revert in the course of a few days to their original character. Oils, deodorized by agitation with fermenting milk or toddy, have been found to remain bland for several months. The accompanying data with regard to the chemical constants, potency and stability of oils deodorized with fermenting milk and toddy as compared with those of the original oil show that very little change in these vital characteristics is involved in the process.

Chemical characteristics

	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
Acid value	0·2	0·3	2·0	2·2
Saponification value	188	199	191	191
Iodine value	128	128	109	108

Vitamin A potency in international units per gram

Species of shark	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
Stegostoma tigrinum	1,200	1,100	3,800	3,800
Pristis cuspidatus	5,900	5,900		
Hammerhead	37,000	36,900		
Bulk sample	11,200	11,100	9,600	9,600

Stability of the oil

Time, days	Peroxide value			
	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
0	9·4	9·8	6·0	4·5
1	17·8	15·9		
2			21·4	23·6
3	47·8	46·4		
4	57·5	60·4	60·8	62·4
6	94·5	96·8	103·9	110·1
8	198·0	210·4		

Brocklesby[1] has indicated that hydrogenation of fish liver oils under carefully controlled conditions would eliminate the malodorous factors while the vitamin A itself may be kept unimpaired. Working with 0·1, 0·25, and 0·4 per cent concentrations of nickel catalysts prepared by the method of Adkins, Covert and Connor[2], we have obtained results which are quite promising. While 0·1 per cent of catalyst is not sufficient to effect complete deodorization (organoleptic test) within a temperature range of 100–180° C., 0·25 per cent of the catalyst effected fairly complete deodorization of the oil at 120° C. within 30–45 min. The percentage loss of vitamin A by this process is about 7, and stability studies have shown that the keeping quality of the oil has improved very considerably. 0·4 per cent of the catalyst caused increased destruction of the vitamin.

The accompanying table, giving results obtained with 0·25 per cent nickel catalyst at temperatures between 100° and 180° C. and reaction periods from 30 to 180 min., shows that the loss of vitamin increases progressively with increase in temperature and time of exposure.

	Time (min.)	Temperature (°C.)				
		100	120	140	160	180
Vitamin A*	30	97·1f†	84·0ff	93·0ff	89·0b	87·0
Vitamin A	60	92·9f	90·0b	85·5	74·8	71·2
Vitamin A	90	91·4ff	86·9b	76·4	68·0	56·9
Vitamin A	120	88·0b	80·2	70·7	56·7	43·0
Vitamin A	150	84·5b	74·3	64·3	48·0	31·3
Vitamin A	180	82·0b		57·0	42·1	20·2

* Percentage of original content.
† f = fishy; ff = faintly fishy; b = bland.

Further studies are in progress, and full details will be published as soon as they are completed. We are grateful to the University of Travancore for research scholarships awarded to two of us (P. K. M. and H. S.).

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[2] Covert, Connor and Adkins, *J. Amer. Chem. Soc.*, **54**, 1651 (1932).

Activities of Associating Solutes

There are comparatively few cases of binary mixtures in which the activity or fugacity of one component has been interpreted in terms of molecular properties. Well-known instances of such treatments are the Debye–Hückel theory of electrolytes and Hildebrand's theory of regular solutions. We have examined the case of a binary mixture where interaction between the two components is negligible, but where one of the components (the solute) has a tendency to form multiplets of any degree of complexity by means of association. Since interaction is

assumed to be negligible, the non-ideality of the solute is attributable entirely to association, and each multiplet species (including the monomer) may be supposed to constitute an ideal sub-system. We propose to call mixtures of this type 'perfect associating mixtures'.

Since the solvent plays an entirely inactive part, a special case of this type is that of a gas, the ultimate molecules of which can associate to give multiplets. The second component (the solvent) is here replaced by the free space between the gaseous molecules. For sufficiently high temperatures and low pressures, each multiplet sub-species may be regarded as forming an ideal gas.

Examples of this type of system are certain solutions of polar solutes in non-polar solvents, and gaseous systems such as sulphur or iodine vapour at high temperatures.

The 'solute' will be considered as an equilibrium mixture of single molecules, doublets, triplets, etc. The total molarity (in terms of single molecules) of the solute will be denoted by n_s and the molarity of the various individual species (in terms of the appropriate multiplet molecules) by x_r. Here $r = 1$ for singlets, $r = 2$ for doublets, etc. If μ_r is the chemical potential of the r^{th} species, then

$$\mu_r = \mu_r^0 + RT \ln x_r. \tag{1}$$

All species exist in equilibrium with one another, hence

$$r\mu_1 = \mu_r. \tag{2}$$

If a definite volume of solution is considered (say 1 litre), x_r may be taken as the masses of the various species (expressed in moles). Hence if G_s is the Gibbs free energy of the solute as a whole

$$G_s = \sum_{r=1}^{\infty} x_r\mu_r = \mu_1 \sum_{r=1}^{\infty} rx_r. \tag{3}$$

If μ_s is the chemical potential of the solute species as a whole

$$(\partial G_s/\partial n_s)_{T,P,n_l} = \mu_s, \tag{4}$$

where n_l is the mass of the solvent in one litre of solution. For n_s, we can write

$$n_s = \sum_{r=1}^{\infty} rx_r. \tag{5}$$

Equation (4) and subsequent equations derived from it would hold for solutions sufficiently dilute for n_l to be effectively constant, that is, for the volume of the solution to be approximately equal to the volume of the solvent. Thus, from equations (3), (4) and (5),

$$\mu_s = (\partial G_s/\partial \textstyle\sum_r rx_r)_{T,P,n_l} = \mu_1. \tag{6}$$

Writing the last equation fully,

$$\mu_s^0 + RT \ln a_s = \mu_1^0 + RT \ln x_1, \tag{7}$$

where a_s is the activity (or the fugacity) of the 'solute' species as a whole. Since at infinite dilution n_s tends to x_1 and also to a_s, the standard chemical potentials μ_s^0 and μ_1^0 must be identical and hence

$$x_1 = a_s. \tag{8}$$

For such mixtures, therefore, the activity of the solute (in molarity units) is identical with the molarity of the singlet species. For the conditions when this is valid (that is, volume of solution approximately equals volume of solvent), it is easily deduced that it is also true that the activity of the solute (in molality units) equals the molality of the singlet species. For the corresponding case for associating gases a similar treatment yields the result that the fugacity of the gas equals the partial pressure of the singlet species.

The application of this new relationship to certain gaseous and liquid systems will be discussed at greater length elsewhere.

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Autoradiography of the Thyroid Gland

Autoradiography of the thyroid gland has been carried out by various methods: (1) mounting sections of tissues containing radioactive iodine on glass slides, applying these slides with pressure against the emulsion of a photographic plate[1]; (2) melting photographic emulsion and pouring it over a section[2]; (3) mounting the sections directly on the photographic emulsion[3]; and (4) a modification of (2), by removing from its base Ilford half-tone thin film, dry-stripping emulsion and mounting it on top of the slide-bearing sections[4].

The first method, although the stained slide and the developed photographic plate may be examined in conjunction, does not permit accurate localization. In the second method a heavy blackening of the emulsion may obscure the section, even though stained. Pelc[4] was unable to stain the section through the emulsion in the fourth method. The third is simple to use, and the section may be stained with ease, and precise histological localization of the blackening of the emulsion obtained. It is well suited for serial sections used in the present work.

In the present experiment, 25 micro-curies of radioactive iodine (I^{131}) was injected in the form of sodium iodide intraperitoneally into a normal adult male mouse. After two hours, the animal was killed with chloroform. The thyroid lobes were removed and fixed in aqueous formalin. Water-soluble iodine compounds are dissolved by aqueous fixatives and may either be removed from the tissue or translated. To obviate this, Pelc[4] fixed thyroid tissue in alcohol. However, it has been shown[5] that autoradiographs obtained by fixing thyroid tissue in aqueous fixatives do not differ from those obtained by freeze-drying. This indicates[5] that iodine is probably rapidly bound to protein in the gland and ceases to become diffusable. Aqueous fixatives are therefore admissible for thyroid autoradiographs.

Following fixation, the thyroid lobes were embedded in wax in the usual way, and serial sections of the whole gland were cut at a thickness of 7 μ. The ribbons bearing the sections were floated on warm water in a dark room and mounted directly on to the emulsion of Ilford thin-film high-resolution plates (4½ cm. × 6 cm.). All sections were mounted in series and dried overnight. Then the wax was dissolved off (paraffin wax absorbs some of the radiation). The plates were re-dried and kept in a light-tight box for six days, then developed by usual methods. The sections remained in place and were later stained with neutral red. (Hæmatoxylin and eosin) tends to obscure the blackened emulsion. Localization of radioactive iodine in the colloid of the follicles was clearly demonstrated by this method. It is known[6] that within half an hour of administration radioactive iodine has begun to accumulate in the thyroid,

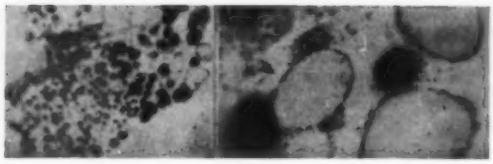

Fig. 1 Fig. 2

Fig. 1. Low-power view (× 40) of autoradiograph of mouse thyroid. Small and medium-sized follicles are blackened; larger follicles are not

Fig. 2. High-power view (× 270) of part of autoradiograph of mouse thyroid. Two large follicles can be seen with practically no blackening of the colloid. In the top right-hand corner can be seen a further large follicle in which the follicular cells are taller than in the other large follicles in the section. The colloid has blackened slightly more than in the others. Two small follicles can be seen which have given an intense blackening

and in the present work (two hours after injection) most of the follicles had shown some signs of concentrating the iodine.

The smallest follicles appeared to have concentrated the radioactive iodine more rapidly than the larger follicles. (Hamilton[7] made a similar observation on the thyroids of two hypothyroid children.) In some very large follicles no blackening in the region of the colloid had occurred. In these the process of concentrating iodine was probably at a very low level or had ceased.

It was found that no part of the thyroid was more active than any other part in concentrating the radioactive iodine. Follicles of different sizes were scattered indiscriminately through different parts of the gland. All the small follicles with cuboidal or near-cuboidal cells had radioiodine in their colloid, and all the large ones showed varying amounts according to the degree of flattening of the epithelium. In some large follicles with moderately flattened cells—although the colloid showed no reaction—there was a rim of blackened emulsion surrounding the colloid and coinciding with the epithelium. It is of interest that blood vessels in the preparations, which must have been carrying radioactive iodine, showed no signs of having blackened the emulsion, presumably because the former is present in too low a concentration. Leblond[8] has shown that, 15 hr. after administration, radioactive iodine is present in greater amounts in acidophilic than basophilic thyroid follicles (Mallory's trichrome stain); he believes the difference is due not to the differing powers of storing radioiodine but to variation in time of retention. The present experiment (2 hr. after administration) suggests that iodine is still being absorbed and that the follicles store it at various rates, and that the more flattened the epithelium the slower the rate of storage (a not unexpected finding). The staining method used did not permit a satisfactory differentiation between acidophilic and basophilic follicles.

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Effect of Phosphorus on the Hydrolysis and Absorption of Sucrose by Plant Cells

SOME years ago I demonstrated[1] that excised barley leaves from phosphorus-deficient plants showed considerably increased respiration intensities if their cut ends were immersed in neutral sodium phosphate solution instead of water. Feeding similar leaves with sucrose solution also increased the respiration-rates; but the increase was much smaller than when phosphorus was administered. The sucrose effect was less apparent when phosphorus deficiency was more acute. Still higher rates of respiration were obtained if the phosphorus-starved leaves were supplied with both sucrose and phosphate together.

Later, I showed[2,3] that when slices from storage organs are floated in sucrose solution, the latter is never absorbed by the plant tissues as such: but it is always first inverted in the medium and the products of inversion are afterwards absorbed. I have recently noticed the same phenomenon when the cut ends of plant leaves are dipped in sucrose solution, the sucrose being hydrolysed before its absorption. Feeding experiments on normal and phosphorus-starved barley plants are now in progress, and the results indicate that when excised phosphorus-starved leaves are dipped in sucrose solution, the rate of sucrose inversion in the medium and also the rate of uptake of the hydrolysis products are remarkably reduced. Feeding with neutral phosphate and sucrose together restores the normal hydrolytic and absorptive capacities to these plants.

This is interesting because it shows that in the early respiration experiments, the sucrose of the culture medium never entered the cells as such; and sucrose could not be synthesized inside the phosphorus-deficient cells because of the lack of phosphorus[4,5,6,7]. It is also evident that the respiratory substrate may be directly produced from sucrose hydrolysis[8,9,10]; but the latter process is extremely affected by phosphorus, being very much reduced under conditions of phosphorus starvation. In this connexion, it may be mentioned that Lyon[11] and Richards[12] advocated the view that phosphate is normally involved in the respiratory breakdown of sugar in plant leaves.

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Crystallization of Whale Myoglobin

ALTHOUGH the spectroscopic differences between blood and muscle hæmoglobin were first observed by Mörner[1] in 1897, it was not until 1932 that Theorell[2] succeeded in crystallizing myoglobin from horse-heart muscle.

The myoglobins from several species of animals have since been prepared by various workers[3,4,5,6], and recently Theorell[7] described the preparation of

crystalline human myoglobin from heart muscle and from the urine of cases of myoglobinuria.

Whale meat is of a very dark colour, and since it is often available, it was of interest to establish whether it is suitable for large-scale preparations of crystalline myoglobin. Two methods of preparation are described below, and in each case good yields of crystalline myoglobin are obtained. For the production of larger crystals suitable for X-ray crystallography, the final crystallization must be carried out in phosphate solutions.

(*a*) *Crystallization of CO-myoglobin* (J. K.). The whale meat (about 4 kgm.) was roughly dissected to remove any neurovascular bundles while it was still frozen solid, cut into small cubes which were inspected for any remaining blood vessels and minced. The mince was extracted with an equal weight of water overnight in a cool place. The fluids obtained first by draining and then by pressing the mince in a hydraulic press were sometimes found to be very greasy and had to be centrifuged to remove the fat as a solid layer from the surface of the fluid. The dark red myoglobin solution was neutralized with 10 per cent sodium hydroxide to *p*H 7·3, and the bulky precipitate formed was removed by filtration through paper pulp. (For all subsequent filtrations a Buchner funnel with hardened paper was used.) The filtrate was brought up to 50 per cent and then to 70 per cent saturation with ammonium sulphate, keeping the *p*H at 7·3, and the resulting precipitates were in each case filtered off and discarded. The pigment which had by now oxidized to metmyoglobin was converted to CO-myoglobin (using a minimal amount of $Na_2S_2O_4$ as reducing agent) as this compound is more resistant to denaturation than metmyoglobin. The pigment was examined spectroscopically after each of the following manipulations, and carbon monoxide was passed through the solution when necessary. The myoglobin was next brought up to 80 per cent saturation with ammonium sulphate, rapidly filtered and the precipitate was discarded. The filtrate was dialysed against neutralized saturated ammonium sulphate until the myoglobin was completely precipitated, when it was filtered off, dissolved in distilled water and reprecipitated by dialysis.

The myoglobin was then fractionated by dialysis against neutralized ammonium sulphate at 60, 70 and 75 per cent saturation respectively, all precipitates being discarded. The filtered CO-myoglobin was finally dialysed against neutralized 80 per cent saturated ammonium sulphate until it was just faintly turbid, when it was transferred to a closed glass vessel and placed in the cold to crystallize. Whale CO-myoglobin prepared by this method forms needle- or lens-shaped crystals arranged singly, in sheaves, or in rosettes. Flat plate-like crystals with parallel sides have also been observed in the course of one preparation.

(*b*) *Preparation of Metmyoglobin crystals* (K. S.). This method was based on the known differences of solubility between the hæmoglobin and myoglobin of any particular species of animal in concentrated phosphate buffer, as described by Morgan[8] and Theorell[7].

A mixture of 491 gm. $NaH_2PO_4.2H_2O$ and 546 gm. K_2HPO_4 was added to 2,100 ml. of an approximately 1 per cent solution of CO-myoglobin previously fractionated with ammonium sulphate and dialysed against distilled water according to Theorell[7]. The resulting precipitate was filtered off and the filtrate saturated with the above phosphate mixture added in small amounts. The pigment having spontaneously oxidized during these manipulations, the precipitated metmyoglobin was filtered off on a Buchner funnel and the phosphate fractionation was repeated three times. After the second fractionation the α-band of the carbon monoxide compound as measured by the Hartridge reversion spectroscope remained constant at 5793 A. Small quantities of a mixture of 9·5 parts K_2HPO_4 and 17·0 parts $NaH_2PO_4.2H_2O$ were added with mechanical stirring until a small permanent precipitate appeared. This was filtered off on a hardened filter on a Buchner funnel. On standing at room temperature for 2–12 hours the metmyoglobin crystallized from the filtrate in dark-brown crystals belonging to the orthorhombic system[9].

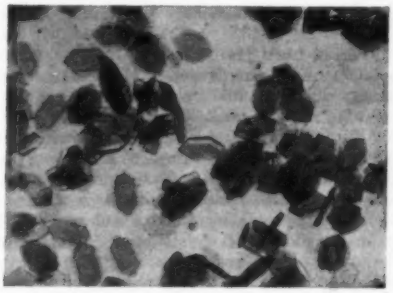

Fig. 1. Phosphate buffer. *p*H 5·7. 3·5 *M*. × 89

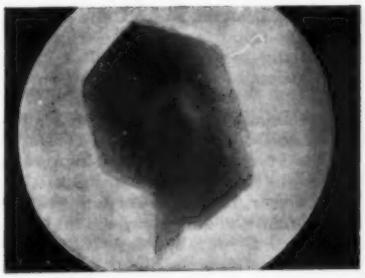

Fig. 2. Phosphate buffer. *p*H 5·7. 3·4 *M*. Large crystal. × 34

We wish to thank Prof. A. C. Chibnall for his interest in this work and Dr. J. G. Sharp of the Low Temperature Research Station for the whale meat. Thanks are also due to the Medical Research Council (J. K.) and to the Stiftung für Stipendien auf dem Gebiete der Chemie (K. S.) for personal grants.

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THE COLONIAL MICROBIOLOGICAL RESEARCH INSTITUTE, TRINIDAD

THE ceremony of the opening of the Colonial Microbiological Research Institute in Port-of-Spain, Trinidad, British West Indies, was performed on July 5 by Lord Hankey, in the presence of a distinguished gathering including the Governor of Trinidad and Tobago, Sir John Shaw; the chairman of the Standing Closer Relations Committee, Sir Hubert Rance; Prof. J. L. Simonsen, director of research of the Colonial Products Research Council; the principal of the University College, Jamaica, Dr. Taylor; the acting principal of the Imperial College of Tropical Agriculture, Trinidad, Dr. Shepherd; and delegates from other Caribbean countries, from the United States, Mexico, Venezuela, Honduras, etc.

Introducing Lord Hankey, the Governor expressed his satisfaction at the presence of Lord Hankey and of so many distinguished delegates; on behalf of the peoples of Trinidad and Tobago he thanked Lord Hankey for having chosen Trinidad for this undertaking, which he understood was to serve as a research centre for theoretical and applied microbiology for the benefit of the Colonial Empire as a whole.

In a message read by Lord Hankey, Sir Robert Robinson, president of the Royal Society, conveyed the following greetings from the Royal Society: "It is impossible to visit any tropical or sub-tropical country without becoming more and more insistently aware of the importance of general microbiological research. In the field of the pathogenic organisms this need has long been recognized, and to some extent satisfied, but the importance of the wider aspect has not been equally well understood. Entirely inadequate provision has been made for such investigations whether from the point of view of pure biology, biochemistry, hygiene and medicine, or of industry. When Dr. Simonsen and I visited Trinidad in 1944, the need for extended microbiological research was obvious to us as a special instance of the general thesis. It was clear, too, that the facilities that could be made available, the side-contacts, and the general conditions were favourable for the development contemplated. Not only the health of the community in the physical sense, but also in the economic sphere, was seen to be tied up with microbiology in its wider implications.

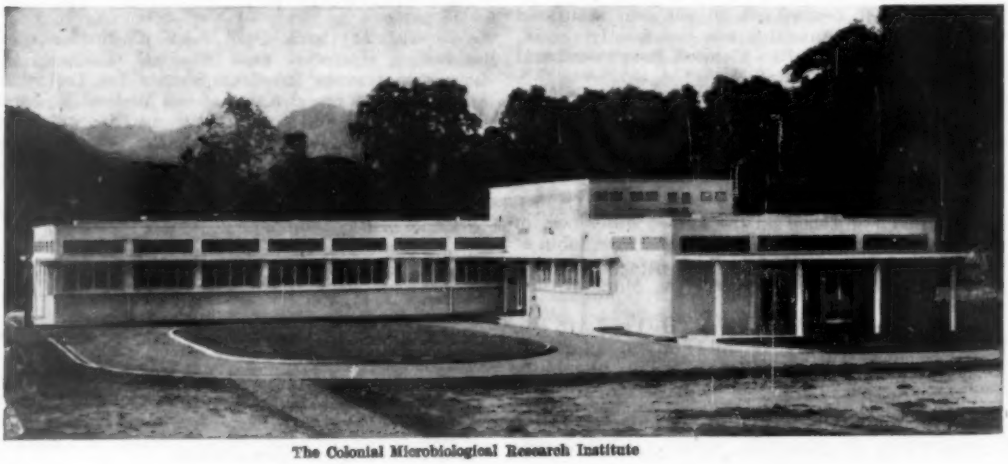
"On return to England, we found as a most fortunate and compelling circumstance that it might be possible to persuade Dr. Thaysen to undertake the organisation and first Directorship of a projected Institute for Microbiological Research. That was decisive and further steps taken are well known to you all. It is with real satisfaction that I send this message of felicitation to an Institute which I am sure is destined, not only to play an important part in the development of Trinidad and the Caribbean, but also to give an example to the rest of the world. It will surely make a significant contribution to science and we hope also to human happiness and prosperity."

In his address, Lord Hankey gave a brief review of British Colonial policy and organisation in scientific research and development in which the Institute is a link, and he sketched the history of the Institute's conception.

Amplifying Sir Robert Robinson's remarks, Lord Hankey asked: "Our aspirations! What are they? I dare not pitch them too high, or we may disappoint you. I must not pitch them too low, because, on a long view, they have no ceiling any more than has the blue firmament above Trinidad. But our first aspiration must be pure research; that wresting from Nature of her secrets; that process of getting to the bottom of things from which great results follow. Think of the pioneer work of Newton, of Faraday, of Herschel, of Pasteur, of Rutherford, and hundreds of others from which have been produced the marvels of modern science. Apply that thought to microbiology and you get some idea of our fundamental aims and ambitions for the microbiological institute.

"But we shall not limit ourselves to pure science. We shall continue, as hitherto, to exploit to the utmost the application of research for the benefit of mankind.

"It will interest you to know that, as the result of a recommendation by the British Commonwealth



The Colonial Microbiological Research Institute

Scientific Official Conference in 1946, the Microbiological Institute in Trinidad has become an official centre for the British Commonwealth for Culture Collections of Micro-organisms, where types of micro-organisms will be carefully preserved. That is essential if full advantage is to be taken of research in microbiology.

"I could give many further illustrations of what we have accomplished in our early, pioneer years, but I have said enough to give some impression of the kind of benefits we hope to derive from the pursuit of microbiology in this Institute; but in saying that, I must again emphasize that pure research must come first and that any deviation from that aim in pursuit of quick results might be calamitous."

Lord Hankey then went on to ask why Trinidad had been chosen for this important work. To begin with, he said, it was essential that the work undertaken in a new centre being intended mainly for the good of the tropical Empire should be undertaken within the tropics. "We were greatly influenced also," he continued, "by previous experience of the danger of placing such an Institute in isolation. Apart from the Caribbean Research Council, Trinidad already houses the famous Imperial College of Tropical Agriculture with its valuable library, and it seemed to us that to place the Institute within easy reach of the College should be of material benefit to both, owing to the close association with other scientists that each would enjoy. In this connexion it is very interesting that Dr. L. F. Wiggins, who has been prominent in assisting Sir Norman Haworth on the important work at Birmingham University on starch and sugar to which I have already referred, has recently been appointed by the West Indies Sugar Association as head of the new Department of Sugar Technology at the College. This should give a splendid start to the development of this branch of the College which was another of the suggestions made by Sir Robert Robinson and Prof. Simonsen.

"We had in mind also the opportunities that the Institute might afford for the important study of soil microbiology, and we did not overlook the prospects of invaluable contacts with the scientists of the Trinidad Government and of the refineries, oil companies and other industrial concerns in the island, as well as its associations, societies, and institutes. In particular we look forward to a close link with the University College of the West Indies.

"But to these more or less official reasons for the selection of Trinidad I would add one more, which makes a special appeal to me, as a layman, and is expressed in language more eloquent and more imaginative than I can command in the following passage from Charles Kingsley's 'At Last', chapter 14, entitled 'The High Woods', which was inspired by his observation of the Trinidad forest, while visiting the island in the last century: 'The eye is not filled with seeing, or the ear with hearing; and never would be, did you roam these forests for a hundred years. How many years would you need merely to examine and discriminate the different species? And when you have done that, how many more to learn their virtues, properties, uses? By what miracle they are compacted out of light, air and water, each after its kind? How, again, these kinds begin to be and what they were like at first? Whether these crowded, struggling, competing shapes are stable or variable? Whether or not they are varying still? Whether even now, as we sit here, the Great God may not be creating, slowly, but surely, new forms of beauty around us.' To sum up—in the words of Lucretius—'*Felix qui potuit rerum cognoscere causas*' (Happy is he who can know the causes of things. Lucretius, 'De Rerum Naturæ')."

After luncheon the company proceeded to the grounds of the Institute and here Lord Hankey unveiled a plaque with the name of the Institute engraved upon it, and opened the main entrance door with a key made of West Indian gold and presented to him by the architects who designed the buildings, Messrs. Watkins and Partners, of Bristol and Port of Spain. At the suggestion of the Director, Lord Hankey graciously consented to have his name associated with the culture collection maintained at the Institute as a link with Commonwealth culture collections of micro-organisms, and agreed that this culture collection in future should be known as "The Hankey Culture Collection" instead of the "Colonial Culture Collection".

A description of the Institute has already been given in *Nature* of July 3, p. 14.

Following the official opening, two morning sessions on July 6 and 7 were held in the library of the Institute. At the first of these Lord Hankey took the chair, and at the second, Prof. J. L. Simonsen. Many delegates and others read papers at these meetings, which were largely attended.

It is hoped, in due course, to compile an abbreviated account of the subjects dealt with in these discussions, and to issue them as a commemorative publication.

J. L. SIMONSEN

SOUND TRANSMISSION AND NOISE

A VERY successful symposium on sound transmission and noise was held during July 14–16 by the Acoustics Group of the Physical Society, with the kind co-operation of the Royal Institute of British Architects, in the Jarvis Hall of the latter, at Portland Place, London. The proceedings were opened by Mr. H. L. Kirke, chairman of the Group, and overseas visitors were present from the United States, France, Denmark, Holland, Sweden, Switzerland, Italy and Germany.

The opening session was devoted to problems of sound transmission. In the first paper, Dr. L. L. Beranek, of the Massachusetts Institute of Technology, described investigations he has been carrying out into the determination of the attenuation of single and multiple panels. To avoid the expense of the usual two-room method, he has developed a model test using panels 18 in. square giving results which agree well with full-scale tests and with theory. He has applied the theory to seven kinds of structures and has deduced charts which enable the attenuation, for partitions of known dimensions, mass and porosity, to be readily determined. Similar work in Great Britain at the National Physical Laboratory was described by Dr. G. H. Aston. He has not found any marked effect with size in the attenuation of glass windows, but there is an upper limit to the mass which it is worth while using set at 24 oz. glass by the compliance of the framing. With double windows there is an increase in attenuation with spacing even up to 7 in. at low frequencies, but 4 in. is sufficient at high frequencies. His work on plaster walls has

shown a curious effect with time, the attenuation showing a cyclical variation during the first few days. He finds that strip metal ties for cavity walls provide much more coupling than wire 'butterfly' ties, especially at low frequencies.

Dr. Theodore Vogel, of the Centre National de la Recherche Scientifique, Marseilles, could not attend, but his paper on the transmission of sound by elastic panels was read by Prof. Canac. It gives a mathematical treatment of the vibration of a thin plate to waves of normal incidence using Lagrange normal co-ordinates. The resulting expression contains the simple piston result of Davis together with a term depending on the panel dimensions. Extensions of the theory to cases of double partitions and panels covered with porous coatings are given, and all the formulæ have been checked experimentally.

Mr. W. A. Allen, of the Building Research Station, Garston, Herts, traced the development of the party wall. The modern standard is an attenuation of 55 db., and no practical single-leaf construction has been found to give this. Two-leaf constructions of 3 in. and 4 in. thickness can reach the required standard; but it is necessary to give special attention to leakage paths, especially windows and chimneys.

Dr. Furrer, of the G.P.O., Berne, gave very interesting and useful information on the elastic properties of various materials in sheet or quilt form suitable for making floating floors to reduce impact sound. His results illustrate the good elastic properties of glass silk.

A joint committee representing Britain, Denmark and Holland has been formulating proposals for measuring insulation to air-borne and structure-borne sound, and these were put forward on behalf of the committee by Dr. Ingerslev, of Denmark. Air-borne insulation results should be corrected to a reverberation time of 0·5 sec. to match ordinary rooms. Impact sound insulation should be determined with closely specified apparatus, and subjective measurement is important. Analysers of $\frac{1}{3}$ or $\frac{1}{1}$ octave bandwidth are used and the results are summed. Dr. Aston described work at the National Physical Laboratory on the insulation of wood joist floors. Using a raft and pugging, he has attained 55 db. insulation to air-borne sound and 20 db. more than an ordinary floor to impact sound.

Measurements of impact sound at London, Copenhagen and Delft were described by Dr. Kosten. Discrepancies were removed by using the same tapping instrument, a 'Rawlplug' hammer.

A record of team-work by the National Physical Laboratory and Building Research Station staffs on the insulation of discontinuous structures was given by Mr. W. A. Allen. Mr. H. R. Humphreys described further work at the Building Research Station on floating floors, giving details of different constructions and results obtained in the laboratory and actual buildings.

The final paper for this session was read for Mr. Kipfer by Mr. P. Germain and described the method developed at the University of Brussels for measuring footsteps noises. In the discussion on the first day's papers, Prof. A. Giacomini made a plea for agreement on acoustical definitions and authors replied to questions, mainly on attenuation in structures. Cases of linear and geometric attenuation in decibels with distance were quoted.

The morning of the second day was devoted to papers of architectural interest, under the chairmanship of Mr. Hope Bagenal. Mr. W. A. Allen presented the results of a survey of domestic noise giving the proportion of people suffering in one way or another from noise. Banging doors appear to cause most trouble, but very careful framing of questions is necessary to obtain reliable information. He emphasized the strain due to self-imposed constraint on one's activities.

A large-scale investigation on a number of experimental flats at Rotterdam was described by Dr. Kosten. Several kinds of walls, ceilings and floors have been tried, together with resiliently isolated piping and sanitary installations. Dr. Kosten continued with a critical examination of similarity or scale tests, and his analysis shows the method to be very useful in determining sound insulation.

A short paper by Dr. J. L. Burn, medical officer of health, Salford, on noise in schools was read by Dr. King. The problem is outlined and results of noise measurements in typical schools are given.

Dr. Grunenwaldt's paper, also read by Mr. Germain, gives noise surveys of the ships *Prinz Albert* and *König Albert* and compares them with earlier surveys by Robinson. The engine rooms have been treated and show 102–106 phons.

Noise on board aircraft as it affects telephony was discussed by Mr. P. Chavasse, chief engineer of the Acoustic Department, Centre National d'Études Télécommunications, Paris. His paper gives general directions for improving telephonic communication on board and includes an analysis of the origin and nature of the various noises.

A complementary paper to Mr. Allen's on domestic noise was read by Mr. P. H. Parkin, also of the Building Research Station, on insulation of flats from sound. The complete programme outlined begins, logically, with a social survey, discusses methods of measurement of attenuation of air-borne and structure-borne sound and gives test results on typical constructions.

Prof. Canac's paper, which he gave in French, on the acoustics of ancient Greek and Roman theatres, came as a welcome change to many present. His studies of the theatres of Orange and Vaison have shown the importance of the various structural features and point out lessons. The relation between the various absorption coefficients was discussed by M. Grunenwaldt. His paper gives the experimental basis for a relation between the Taylor and Sabine coefficients.

In the ensuing discussion, Dr. Beranek referred to the calculation of loudness from analyses and Dr. King outlined the method, originally due to Dr. B. G. Gates, which he uses. Dr. Mintz, U.S.A. Navy Department, suggested an accelerometer instead of velocity meter for similarity tests.

The morning of the third day was devoted to noise measurement, the chairman being Mr. W. West. The opening paper by Mr. R. S. Dadson, of the National Physical Laboratory, gives a survey of the problem of noise measurement, outlining the difficulties in making measurements in the field in terms of the fundamental unit of equivalent loudness. He compares the performance of objective and subjective meters particularly on motor-car exhaust noise, and points out the necessity for general agreement on equal loudness contours and the summation of analyses.

Dr. A. J. King's paper on a portable objective noise meter refers briefly to the errors of sound-level meters on complex noises and describes a much simplified peak/R.M.S. meter. Readings on typical

noises are compared with subjective and sound-level meters showing less errors than the latter.

A mains-driven meter operating on the same principle was described by Mr. D. A. Nutt. This instrument conforms to the standards of the Acoustical Society of America but also incorporates peak/R.M.S. measurement. It is intended for routine factory use.

M. P. Baron gave his paper on objective noise measurement in French. He feels that objective meter readings and summations from analyses are unreliable and should be confined to comparing similar noises.

In his paper, Mr. Maurice, of the B.B.C., deals with a different aspect of noise, namely, interference with broadcast reception. He has correlated subjective assessment of interference with readings by various meters and finds a weighted energy meter gives the closest correlation.

The paper by Lord Halsbury describing a rapid wave analyser was read in his absence by Mr. D. G. Jaquess. The instrument is a heterodyne analyser covering 0–30 kc./s. with provision for sweeps of $\frac{1}{2}$ to $\frac{1}{4}$ sec. and maximum resolution. It also permits more detailed examination of a 2 kc./s. band.

In his paper on the reduction of noise in aircraft, Mr. N. Fleming, of the National Physical Laboratory, deals with the contributions from the engine, propellers, aerodynamic flow and auxiliaries. He has studied octave frequency bands in each case and he shows the effects of power, tip speed and air velocity.

M. P. Chavasse read his paper describing an apparatus to produce complex sounds and artificial voices for acoustic tests in French. It is based on valve noise with suitable modulation to simulate the voice. Results obtained with it agree well with those for the natural voice.

In the discussion after this session, Dr. Beranek described recent work in the United States tending to confirm the level high-intensity equal loudness contours. He questioned the differences between pressure and field sensitivities of the ear, hinting at an obscure effect. He also asked for terminological agreement on 'random' and 'white' noise. Mr. Fleming objected to the indiscriminate use of phons for decibels, and Dr. Furrer asked about the calculation of loudness from analyses.

For the final session Mr. Kirke was again in the chair, and papers covered a wide range of applied acoustics. First, Dr. L. Cremer, who had only just arrived from Munich, read his paper on sound insulation at oblique incidence. Consideration of the travelling waves along a panel with a sound at oblique incidence suggested to him that grooves in the panel would improve attenuation. His paper gives the theory and experimental confirmation.

Dr. Kosten had had to return to Holland, so the joint paper on sound absorption in layers of material was read by J. van den Eijk. The paper gives the theoretical performance of such layers and includes experimental confirmation.

In his paper on noise in air ducts, Dr. Grunenwaldt gives the results of noise measurements on several ventilation systems with various air velocities and duct lengths. These data enable him to design duct systems for given room noise conditions.

The paper by Dr. A. Schoch, of Göttingen, on absorption by gradual transition gives the theory for successive layers of material of increasing density, leading up to the modern wedge construction. He takes as an example a linear wedge structure and gives curves for its performance.

Mr. C. A. Mason described the development of quiet chokes for use with fluorescent lamps. His paper examines the essential causes of the noise—magnetostriction and bad joints—and shows the stages followed in their reduction. He also considers the noise of a number of chokes.

In his paper on the elastic properties of rubber, Dr. E. Meyer, of the University of Göttingen, describes an elegant method using a sample in a resonant column of liquid. This gives bulk modulus and dissipation, while Young's modulus is given by longitudinal resonance or travelling waves. The frequency range covered is 10 c./s. to 20 kc./s. Effects of temperature and load are also discussed.

Mr. C. H. Bradbury's paper discusses the noise of machines, especially Diesel engines. He gives noise spectra and considers the pitched and unpitched components. He emphasizes the shock excitation of damped systems and uses a loud speaker to show up resonances. He also considers the effect of background noise.

Owing to the unavoidable absence of Prof. P. Bruel, Dr. V. L. Jordan, Mr. E. N. Storr and Mr. R. S. Hogben, their papers were not read but will be published in the *Proceedings*.

There were many contributors to the closing discussion. Among them, Mr. Fleming quoted work at the National Physical Laboratory disagreeing with Dr. Cremer on grooves and he also suggested that 'frequency of troubling' should be included in Mr. Allen's questionnaire. Mr. Mason asked about the critical frequency between dynamic-static properties of rubber, and Dr. Meyer gave it as 1 or 2 c./s. Dr. King said he was investigating the matter and thought it would be nearer 0·1 c./s. M. Brillouin gave a humorous contribution suggesting that the phon is insufficiently defined for practical purposes, but Mr. Fleming, chairman of the British Standards Institution Committee on Noise Measurement, gave a convincing reply.

A. J. KING

MIDDLE EAST OIL

THE name of that distinguished American geologist and statistician, Dr. Everette de Golyer, has been proverbial in international oil technology for many years past. He has an almost uncanny flair for predicting correctly the trend of events in the petroleum world, and his forecasts on developments in those countries comprising the Middle East are no exception. So long ago as 1925 the writer remembers de Golyer saying that "he expected from Persia a continued increase in production, as handling and marketing facilities are increased, so long as the fields may last". Nearly twenty years later, when leader of the United States Petroleum Commission to the Middle East, he stated that "the centre of gravity of world oil production is shifting from the Gulf – Caribbean area to the Middle East and is likely to continue to shift until it is firmly established in that area". That this has actually happened is probably not generally appreciated: the economic, technical and political implications of the fact have yet to be assimilated by the public, quite apart from the industry itself. To this end an up-to-date, straightforward survey of the position is essential to its understanding, and the *Petroleum Times* has rendered signal service by publication of its "Review of Middle East Oil" (London, June 1948, 7*s*. 6*d*.).

This review is not a mere compilation. It presents 'eye-witness' accounts of the shape of things concerning oil in Iran, Iraq, Bahrein, Saudi Arabia and Kuwait as they are to-day. It is based fundamentally on a two-months tour of the oilfields at the close of 1947 undertaken by Dr. C. T. Barber, joint editor of the *Petroleum Times*, with reinforcements by Dr. G. M. Lees, chief geologist of the Anglo-Iranian Oil Company, Ltd., Max Weston Thornburg, war-time petroleum adviser to the U.S. State Department, Christopher Holme, well-known writer and broadcaster on Middle East affairs, and T. D. Weatherhead, technical manager, Hunting Aerosurveys, Ltd.

Consider first some vital statistics that emerge from this survey. In 1936 the proved oil reserves of the world were proportioned as follows: U.S.A., 48·1 per cent; Middle East, 21·1 per cent; U.S.S.R., 12·9 per cent; Caribbean and Mexico, 9·7 per cent; and the rest, 8·2 per cent. In 1944 the figures were 33·9, 42·3, 9·0, 10·0 and 4·8 per cent, respectively. Thus in eight years Middle East reserves were doubled. Next are the production figures. In 1936, the U.S.A. produced 60·7 per cent, Middle East 5·4 per cent, U.S.S.R. 11·9 per cent, Caribbean and Mexico 13·2 per cent, and the rest 8·8 per cent of the world total output of crude oil. In 1947 the figures were 63·6, 9·8, 5·5, 17·3 and 3·8 per cent, respectively. Again, in the intervening years, Middle East nearly doubled its production. Further, with 42 per cent of world reserves, the Middle East produces 10 per cent of world output and in 1947 was drawing on reserves at the rate of 1·14 per cent per annum. By contrast, the United States with 33·9 per cent reserves produce 64 per cent of world output and are drawing on reserves at the rate of 9·25 per cent per annum. Still more striking, as Dr. Barber shows, is the fact that in 1947 Middle East production of 306 m. barrels was obtained from 223 wells, an average of 1·37 m. barrels per well, whereas the United States production of 1,985 m. barrels was obtained from more than 425,000 wells, an average of 4,660 barrels per well.

It is commonly believed that the present drastic rationing of petrol in Great Britain is a post-war legacy and a dollar-saving necessity. Why, it is asked, if we control such enormous oil production in the Middle East, is petrol so short in Britain, and why import from the Americas? The fact is that dollar-saving is not the whole story by any means. All over the world people are using more and more oil. In 1947 the American demand was 73·1 per cent more than in 1938; the demand in Great Britain was 45·3 per cent more; the British Commonwealth as a whole consumed over 100 per cent more, while other countries increased their demand by 17·2 per cent. In other words, the world oil demand has increased more than 50 per cent in the nine-year period, accounted for largely by heavily increased requirements of the United States for military, agricultural, domestic and transport purposes. C. J. Bauer has estimated that world demand in 1951 will be 23·4 per cent greater than that for 1947, and to meet this unprecedented rise the Middle East fields will have to increase production by 100 per cent by that year. From all that transpires in the present "Review of Middle East Oil" there appears to be no reason why this should not happen, particularly as the European Recovery Plan allows for 82 per cent of Western European demands for petroleum being met from Middle East resources in 1951.

Besides the purely economic aspects, technical developments of a high order of efficiency will be essential if the 1951 target is to be reached. In this direction optimism is well sustained, if past history of this great oil province is anything to go by. The achievements of the oil companies concerned, not excepting the cultural and social evolution of the native populations, constitute alike a fine record and a model of how things should be done in all spheres of exploiting mineral resources in virgin territory. The "Review" covers these activities and illustrates them, too, in a most convincing manner. It is a valuable publication, one to be commended to all who wish to understand the present problem of oil supply and its vital incidence on international politics in these critical times.

H. B. MILNER

CONCENTRATION OF COBALT BY MICRO-ORGANISMS AND ITS RELATION TO COBALT DEFICIENCY IN SHEEP

By DR. J. TOSIC

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AND

DR. R. L. MITCHELL

Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen

WORK on wasting diseases in Australia[1,2] and New Zealand[3], and 'pining' in the United Kingdom[4,5], has established that cobalt is an essential factor in ruminant nutrition. Deficiency of cobalt results in various wasting diseases, the literature of which has been adequately reviewed[6,7,8,9]. In contrast to the ruminant, it appears that non-ruminants, for example, the rat[10] and the rabbit[11], require very little, if any, cobalt in the diet, for they can thrive on diets containing cobalt in concentrations much below those which would cause wasting diseases in ruminants.

Recent work[12,13], in which radioactive cobalt was injected intravenously into adequately fed cattle, showed that most of the isotope injected was excreted in the urine, and that only small amounts were found in the milk and saliva and none in the rumen content; radioactive cobalt introduced directly into the rumen was excreted chiefly in the fæces, and none was detected in the blood, saliva or milk, thus suggesting relatively poor absorption of the element. Although it is known that the liver is the storage organ for cobalt in sheep[14] and cattle[15], and that the cobalt content in the liver of a cobalt-deficient sheep is considerably lower than that in a healthy sheep on good pasture[14], the mechanism of the action of cobalt in animal nutrition remains still unknown. Using an as yet unpublished procedure[16] for the separation of rumen micro-organisms and other fractions of the rumen contents, and after chemical concentration[16] applying a spectrographic method[17] to the quantitative determination of cobalt in the rumen fractions, we have been able to demonstrate that rumen micro-organisms accumulate cobalt from their external environment. Since we find that a large proportion of the cobalt present in the rumen of a sheep is situated in the rumen micro-organisms, it is possible

that in cobalt-deficient sheep the host and the microbial population of its rumen compete for the already low concentration of cobalt available in the feed, and in this way accentuate a deficiency at the place(s) of its physiological function.

In this work we have used three sheep with rumen fistulæ[18]. One, a two-year-old wether (*A*), gained weight on a seeds hay diet (0·27 p.p.m. cobalt in dry matter). The other two wethers, kindly placed at our disposal by Dr. A. T. Phillipson, of the Rowett Institute, and bred originally on a cobalt-deficient pasture, were maintained on a hay diet containing only 0·07 p.p.m. cobalt in dry matter but otherwise adequate. One of these animals (*B*) remained in poor condition (weight at 10 months, 60 lb.) and served as control, while the other (*C*) was dosed daily (during the morning feeding) with 1 mgm. Co (as cobalt chloride) for a period of six weeks. At the end of this period, when sheep (*B*) and (*C*) were about ten months old, rumen contents were collected (10 hr. after last feed) and fractionated. The fractions separated were examined microscopically and were as follows: fraction I, consisting mainly of protozoa and large rod-shaped bacteria, some smaller bacteria occurring singly, in chains, sarcina-like and in other irregular formations, in addition to a fair proportion of finer plant particles; fraction II, similar in microscopic appearance to I but almost completely free from protozoa and plant particles; fraction III, consisting principally of small cocci occurring mostly singly; fraction IV, consisting of coarser plant particles almost free from micro-organisms adhering to their surfaces; and fraction V, consisting of the supernatant rumen liquid after the separation of fractions I–IV, containing a small proportion of rumen micro-organisms still remaining suspended in the liquid. There was no marked difference in microscopic picture in comparable fractions separated from sheep *A*, *B* and *C*. The total dry matter, and nitrogen, ash and cobalt (on dry matter basis) were determined for each fraction, but for brevity only figures for cobalt are given (Table 1) in this preliminary note.

Our data show that, in the adequately fed sheep (*A*), the cobalt content of the micro-organisms is some three times the cobalt content of similar microbial fractions from the rumen of a sheep (*B*) consuming cobalt-deficient hay. But in sheep (*C*) consuming cobalt-deficient hay and dosed with 1 mgm. cobalt daily, the cobalt content of the microbial fractions is about five times that of a similar sheep (*B*) receiving no cobalt supplement. When cobalt contents of microbial fractions I, II and III are compared with those for the respective supernatant rumen liquids (cobalt content of which in *A* and *B* is probably contributed mainly by the remainder of suspended micro-organisms and in *C* by the daily dosage of cobalt supplement), and the hay fed, it is apparent that rumen micro-organisms concentrate cobalt from their external environment.

Table 1. Cobalt contents of microbial and other fractions separated from rumen contents of sheep fed cobalt-adequate hay or cobalt-deficient hay with or without addition of cobalt (as p.p.m. Co in dry matter)

Fraction	Sheep fed on: (*A*) Adequate hay	(*B*) Cobalt-deficient hay with no cobalt added	(*C*) Cobalt-deficient hay with 1 mgm. cobalt added daily
Microbial (I)	1·85	0·58	3·51
Microbial (II)	3·81	1·49	5·70
Microbial (III)	3·80	1·55	8·25
Plant particles (IV)	0·19	0·12	4·00
Supernatant liquid (V)	0·12*	0·16*	1·94
Total rumen contents before fractionation	0·67	0·29	2·22
Hay as fed	0·27	0·07	0·07

* Probably due mainly to residual suspended micro-organisms.

Using our results in order to calculate the contribution of each of the separated fractions towards the dry matter of the unfractionated rumen contents, in Table 2 cobalt data are derived for each fraction in terms of micrograms of cobalt per 100 gm. of fresh rumen contents and as percentage recovery from, and distribution in, total rumen content. Good agreement has been obtained between the total cobalt in the rumen contents and the sum of the contributions of the individual fractions. From Table 2 it is seen that most of the cobalt found in the rumen contents is found in rumen micro-organisms (about 80 per cent in undosed animals), and that only a small proportion of the total cobalt is found in the external environment (fractions IV and V), except in sheep *C*, where greater amounts of cobalt were present in the supernatant fluid, due to the daily cobalt dosage.

From our findings it appears that, in sheep, the cobalt content of the microbial population of the rumen is related to cobalt concentration in the diet. If cobalt is essential for micro-organisms, but not for the host, then absorption of the element by the host

Table 2. Distribution of cobalt in separated fractions from rumen contents and contribution of those to the total rumen contents

Fraction	Sheep fed on: (*A*) Adequate hay		(*B*) Cobalt-deficient hay with no cobalt added		(*C*) Cobalt-deficient hay with 1 mgm. cobalt added daily	
	μgm. Co/100 gm. rumen content	% of total rumen content	μgm. Co/100 gm. rumen content	% of total rumen content	μgm. Co/100 gm. rumen content	% of total rumen content
Microbial (I)	1·13	39·5	0·69	52·3	3·67	31·1
Microbial (II)	0·34	11·9	0·10	7·6	0·55	4·7
Microbial (III)	0·95	33·2	0·40	30·3	2·63	22·3
Microbial total	2·42	84·6	1·19	90·2	6·85	58·1
Plant particles (IV)	0·39	13·6	0·22	16·7	1·98	16·8
Supernatant liquid (V)	0·15*	5·2*	0·21*	15·9*	2·49	21·1
Total of individual fractions	2·96	103·5	1·62	122·8	11·32	96·0
Total rumen contents before fractionation	2·86	100·0	1·32	100·0	11·80	100·0

* Probably due mainly to residual suspended micro-organisms.

would deprive the micro-organisms of a factor essential for their growth and/or metabolism. It may even be that pining and other wasting diseases are due to cobalt deficiency of the bacteria, the animal requiring not cobalt but the bacterial products which have thereby become deficient. If cobalt is an essential metabolite for the host alone, then its concentration in micro-organisms may reduce its availability for the host. In this connexion it is of great interest that cobalt has been found to occur to the extent of 4·0 per cent of the crystals (dried *in vacuo*) of the naturally occurring anti-pernicious anæmia factor[19]. It is possible that both the host and the microbial population of its alimentary canal require cobalt for their respective metabolic activities. On a low cobalt diet these competitive relations may assume some importance in the etiology of cobalt-deficiency diseases. How far cobalt found in rumen micro-organisms, after leaving the rumen, can be made available for absorption by the host or for intake by its microbial population in the lower parts of the alimentary canal, and with what result, remains to be shown experimentally, together with the points raised earlier.

Full details of this work involving a study of several trace elements in rumen micro-organisms, and certain pure cultures of bacteria and yeasts, will be published elsewhere.

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LARDER OF THE RED-BACKED SHRIKE

MR. J. H. OWEN has given some interesting information about a bird the habits of which are little known to present generations because the bird has become so scarce (*British Birds*, **41**, No. 7; July, 1948). From observations it would appear that all red-backed shrikes (*Lanius c. collurio*) make larders provided they do not need the catch when it is taken. The male bird seems much more given to 'lardering' than the hen, and as many as six larders may be used by one pair of birds. Usually the larders are not far from the nest, but some have been reported 150 yards away. Often the number of larders is one or two. Shrikes prefer to nest in one of a number of isolated bushes, provided one of them is suitable, rather than in a hedge. Hedgerow larders are usually not at all easy to find. The favourite bushes are hawthorn or blackthorn, especially a part that has been killed by fire or some other means. The large thorns on rough briars and brambles are frequently used as larders, and occasionally barbed wire is also used. Larders often have a considerable number of humble-bees (*Bombus*) in them, often a small bird and, occasionally, a house-mouse (*Mus domesticus*) is found.

Queen humble-bees figure prominently in the larders. The birds usually devour workers and males, carder bees and honey bees (*Apis*) as they catch them. Sometimes wasps (*Vespa*) are taken and the remains found in pellets; but it is rare to find a wasp in a larder. Dor-beetles (*Geotrupes*) and cockchafers (*Melolontha*) are seen pinned up. Insects are usually pinned through the underside of the thorax, back uppermost; but occasionally some are pinned through sideways or through the back. The victims are often found alive. Larders are more likely to contain food at night than in the morning, and on cold misty mornings the larder that was well stocked at night is often empty. Among the young birds which were found were willow-wrens (*Phylloscopus trochilus*), whitethroats (*Sylvia communis*), linnets (*Carduelis cannabina*), and pipits (*Anthus*), while common lizards (*Lacerta vivipara*), field-voles and wood mice (*Apodemus sylvaticus*) are also taken.

The larder is used for other purposes than feeding. Often the old birds will carry sacs of excrement from the nest and place them on the tips of thorns in a regular larder. This always occurs when pellets are thrown up by the young. Attempts have been made to pin up dead small birds and mammals in the larders. Observations have shown that these have never been pinned up to the satisfaction of the shrikes, and usually a cock bird pulls the bodies free and fixes them elsewhere. There is a certain amount of evidence to show that the hen fetches food from the larder much more than the cock, although he alone may provision it. Both may use it to cram the young before a thunderstorm, for example, or if they have been kept away from the nest for some time.

T. H. HAWKINS

WAVE MECHANICS IN SCIENTIFIC RESEARCH

PROF. C. A. COULSON'S inaugural lecture as the first professor of theoretical physics at King's College, London, which he delivered on March 2, 1948, is printed in full in the July issue of *Science Progress* (**36**, 436; 1948). Taking as his subject, "Wave Mechanics in Physics, Chemistry and Biology", Dr. Coulson shows, by several well-chosen examples, that wave mechanics, in spite of its early successes, does not provide neat, complete solutions to all physical and chemical problems, thus obviating experimental research; but, as a branch of theoretical physics, is most useful in correlating different pieces of information and in bringing out the essential underlying character of what is observed and measured.

From de Broglie's concept of a particle as a wave, enunciated in 1924, Schrödinger in 1926 treated the simple case of the non-relativistic and unperturbed hydrogen atom and introduced the wave equation, that equation which replaces the ordinary Newtonian

equation of motion of the particle. He showed that the rules of quantization were automatically obeyed. The subsequent generalization and wide application of Schrödinger's wave mechanics proved remarkably successful, but there were limitations. One-electron problems or problems with separable variables could be dealt with; but the equations for H_2, the simplest molecular problem, or for the reaction $H + H_2 \rightarrow H_2 + H$, which is the simplest three-electron problem of chemical interest, to say nothing of the more complicated problems of large molecules, are insoluble. These severe limits to the complete calculation of almost any single physical or chemical property led to considerable despondency, and this despondency, it is Dr. Coulson's belief, is due to a wrong conception of the true function of wave mechanics. "Wave mechanics", to quote Dr. Coulson, "is the key—or perhaps *a* key—to the future of physics, chemistry and biology. However, when we open doors with it we do not find completely worked out, neat solutions to all our problems, but new ideas, new principles, new understanding of processes the details of which we shall probably never calculate to 'so many' significant figures, and new relations between apparently unrelated properties."

The examples chosen by Dr. Coulson to illustrate his meaning are taken from fields in which he has made important contributions. They include: atomic and molecular structure, referring briefly to stereochemistry, and to the structure of benzene, which introduces the general phenomenon of 'resonance' and the idea of fractional bond order; electrons in metals, and the understanding of conduction, photo-conduction, fluorescence, etc., which has resulted from the idea of bands of energy-levels but without the band distribution of any single metal ever having been completely calculated; colour; chemical reactions; and finally, the very large molecules from which the nature of life may be determined.

THE HATHERLY BIOLOGICAL LABORATORIES, UNIVERSITY COLLEGE, EXETER

By Prof. JOHN CALDWELL

THE foundation stone of the Hatherly Biological Laboratories of the University College of the South-West, Exeter, was recently laid by the Marquess of Salisbury, president of the College, in the presence of representatives of the County, the City and the College. When the building is completed, as it is hoped, within the next two years, it will accommodate the Departments of Botany and Zoology, which are, at present, housed in very inadequate and cramped quarters in the Old College buildings in the centre of the city.

The War has, of course, greatly impeded the development of the College as regards buildings, and the estate which the College acquired some twenty-five years ago affords great opportunity for building development, though inevitably that development must be temporarily delayed. It is fitting, therefore, that the first of the post-war buildings should be for the Biological Departments in a College which serves primarily an essentially agricultural area, so that these Departments may have adequate space for the development of their work in the service of the community.

The erection of the Laboratories has been made possible by a bequest of the estate of Mrs. Heath, supplemented by grants from the University Grants Committee. The teaching and research work of the biological departments has expanded very greatly from the time of the appointment of the late J. L. Sager as head of the Department of Biology in the Royal Albert Memorial College in 1907. The scope of the Department increased rapidly right from the beginning, and in 1928 a Department of Zoology was set up under Dr. G. Lapage, who was succeeded on his appointment to Cambridge by Mr. L. A. Harvey, the present head of the Department of Zoology. Mr. Sager continued as head of the Department of Botany until his retirement in 1935, when he was succeeded by the present writer, who had previously been on the staff of the Department of Plant Pathology at Rothamsted Experimental Station. Both Departments in the College, as is common to all university departments at present, are overcrowded and badly in need of additional accommodation.

When the new Laboratories are completed, each Department should have adequate accommodation for reasonable expansion. Each will have three large main laboratories and a small laboratory for honours students, with adequate private rooms, preparation and lecture rooms. There will also be a large lecture room, museum accommodation and dark rooms, tank and constant-temperature rooms for general use.

The building, which is designed by Mr. E. Vincent Harris, is in the form of a main block with private rooms and caretakers' quarters on the front, with five bays running back from it in which are situated the laboratories. This arrangement will allow of the maximum of light being available in the laboratories without having a south exposure.

As the site is on the College estate on the outskirts of the city, there is a considerable amount of ground available behind and around the building, which it is proposed to lay out for botanical collections and experimental ground with glasshouses. The whole should eventually form an ideal unit for biological investigation and teaching. The Departments have now, even under the present conditions, a wide range of research work on hand. On the botanical side, various aspects of virus diseases are being studied, both on the more general side and on diseases of specific crop plants common in the region.

Other phytopathological work includes the study of the ecology of fungi in relation to plant disease, investigation of the Erysiphales, and of the rust of *Chrysanthemum* and similar studies. The cytology of various plants is being investigated as well as more general cytogenetical subjects. At the same time there is a considerable amount of work being done on the cultivation of various plants of some economic importance, and a study of their anatomy and physiology in relation to different cultural methods. It is hoped also to expand and develop an ecological survey of a portion of Dartmoor.

On the zoological side investigations are being carried out on the ecology of areas in the south-west with special reference to Lundy, on some aspects of parasitic protozoology and on some problems of human fertility.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, September 28

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Paul Bloomfield: "The Eugenics of the Utopians; the Utopia of the Eugenists".*

Tuesday, September 28—Thursday, September 30

SOCIETY OF CHEMICAL INDUSTRY (at the University, Leeds).—Conference on "Dust in Industry".

Tuesday, September 28

At 9.30 a.m.—"Physical Characteristics and Estimation of Dust"; at 2.30 p.m.—"Practical Aspects of the Dust Problem", Part 1.

Wednesday, September 29

At 9.30 a.m.—"Practical Aspects of the Dust Problem", Part 2; at 2.30 p.m.—"Fire and Explosive Hazards".

Thursday, September 30

At 9.30 a.m.—"Health Hazards"; at 2.30 p.m.—Summation of the Work of the Conference.

Wednesday, September 29

TELEVISION SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Mr. Arthur Blok: "Some Personal Recollections of Sir Ambrose Fleming" (Third Fleming Memorial Lecture).

SOCIETY FOR VISITING SCIENTISTS (joint meeting with A.S.L.I.B., at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Dr. F. R. Ranganathan: "Self-Perpetuating Classification—the Need and Possibility".

Wednesday, September 29—Thursday, September 30

INSTITUTE OF WELDING.—Autumn Meeting.

Wednesday, September 29

At 2.30 p.m. (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Discussion on "Technical Training for the Associate-Membership Examination of the Institute" (to be opened by Mr. T. R. B. Sanders).

Thursday, September 30

At 10.30 a.m. (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1).—Dr. H. G. Taylor: "Some Aspects of Welding Research in Great Britain and America" (Session arranged by the British Welding Research Association); at 2.30 p.m. —Discussion on "The Training of Welders" (to be opened by Mr. F. Clark, Mr. S. W. Carpenter and Mr. R. J. Fowler); at 6 p.m.—M. André Goelzer: "Repair and Reinforcement of Metal Bridges by Welding".

Thursday, September 30

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. Peter G. Masefield: "Some Economic Factors in Civil Aviation, with Emphasis on Civil Aircraft and their Prospective Trends of Development" (Fourth British Commonwealth and Empire Lecture).

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (in Room B1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield), at 6.30 p.m.—Symposium on "The Limitations of Statistical Methods".

Saturday, October 2

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, NORTH OF ENGLAND SECTION (joint meeting with the PHYSICAL METHODS GROUP, at the Stork Hotel, Queen Square, Liverpool), at 2 p.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

TECHNICIAN to take charge of the Medical Unit Laboratory—The Secretary, St. Mary's Hospital Medical School, Praed Street, London, W.2 (October 1).

SCIENTIFIC OFFICER (male) for work on cereal breeding, a SCIENTIFIC OFFICER for work dealing with virus diseases of potatoes, and a SCIENTIFIC OFFICER to work in collaboration with other members of the plant breeding staff on genetical and cytological problems—The Secretary, Scottish Society for Research in Plant Breeding, 8 Eglinton Crescent, Edinburgh 12 (October 2).

LECTURER (man or woman) IN AGRICULTURAL SCIENCES, and a LECTURER (man) IN AGRICULTURE (farm implements, building construction, etc.), at the Cheshire School of Agriculture, Reaseheath, Nantwich—The Director of Education, County Education Offices, City Road, Chester (October 2).

RESPONSIBLE LECTURER IN MECHANICAL ENGINEERING, a LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN MATHEMATICS for engineering students—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (October 2).

ASSISTANT AGRICULTURAL ECONOMIST or an INVESTIGATIONAL OFFICER AND CLERK ACCOUNTANT—The Registrar, The University, Leeds 2 (October 4).

RESEARCH ASSISTANTSHIPS (2) for work on (*a*) physical and chemical aspects of selective flotation, and (*b*) mining research problems—The Registrar, The University, Leeds 2 (October 4).

ASSISTANT ADVISORY OFFICER IN AGRICULTURAL BOTANY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (October 9).

LABORATORY TECHNICIAN IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (October 9).

MECHANICAL AND ELECTRICAL ENGINEERS in the Higher Departmental Grades in the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1 (October 12).

RESEARCH OFFICER to undertake research and assist in the work of the Photometry Laboratory (Ref. No. 1917), a RESEARCH OFFICER to assist in physical investigations at low temperatures (Ref. No. 1918), and RESEARCH OFFICERS (2) to undertake research on the physical properties of wool fibres and related materials (Ref. Nos. 1919 and 1920), in the C.S.I.R. Division of Physics, Sydney—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 16).

RESEARCH OFFICER IN THE C.S.I.R. DIVISION OF INDUSTRIAL CHEMISTRY, Melbourne, to assist in the X-ray crystallographic investigations of the Division's Chemical Physics Section—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Ref. No. 1913 (October 16).

BROTHERTON RESEARCH FELLOWSHIP IN PHYSICAL CHEMISTRY, and the BRADFORD DYERS' ASSOCIATION RESEARCH FELLOWSHIP—The Registrar, The University, Leeds 2 (October 18).

ASSISTANT PROFESSOR IN INORGANIC TECHNOLOGY at the Faculty of Engineering, Fouad I University, GIZA, Egypt—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (October 18).

MECHANICAL PRODUCTION ENGINEER, and MECHANICAL DESIGN ENGINEERS (2), for the G.P.O. Engineering Department (Research Branch), Dollis Hill, N.W.2—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2288 (October 21).

TECHNICIANS (2) in the Engineering Research Laboratory; TECHNICIANS (4) in the Standards Laboratory; a SENIOR MECHANICAL DRAUGHTSMAN and MECHANICAL DRAUGHTSMEN (2) in the Design Section; a TECHNICIAN in the Workshops Planning Section; TOOLMAKERS (4) in the Machine Room, and a LEADING HAND TOOLMAKER and a TOOLMAKER in the Grinding Room, of the Precision Metal Workshop; a TECHNICIAN in the Electrical, Electronics and Acoustics Laboratory; and TECHNICIANS (2) in the Instrument Testing and Development Section; of the Dominion Physical Laboratory at Wellington—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (October 30).

LIFE FELLOWSHIP IN BOTANY—The Registrar, Trinity College, Dublin (January 1).

ENTOMOLOGIST IN THE MEDICAL DEPARTMENT (Sleeping Sickness Service), Nigeria—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

WORKS CHEMIST to undertake production and/or development responsibilities on shift work (if necessary) in a chemical factory of the Department of Atomic Energy, Springfield's Factory, Salwick, Preston—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

TECHNICIANS (2, Grade III) IN THE DEPARTMENT OF BOTANY—The Secretary, University College, Gower Street, London, W.C.1, quoting "Botany/1".

LABORATORY TECHNICIAN (Grade B) IN THE DEPARTMENT OF PHARMACOLOGY—The Secretary, Medical College of St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

SENIOR RESEARCH WORKER (with extensive experience in modern biochemical or experimental physiological methods as applicable to research in psychiatry)—The Medical Superintendent, Bristol Mental Hospital, Fishponds, Bristol.

PHYSICAL CHEMIST or a PHYSICIST to undertake fundamental work on metal finishing problems including electrodeposition and electropolishing—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

INSTRUMENT MAKERS (2, Grades I and II) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Secretary, University College, Gower Street, London, W.C.1, quoting "Elec. Eng./1".

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of the Ministry of Health for the Year ended March 31st, 1947, including the Report of the Chief Medical Officer on the State of the Public Health for the Year ended 31st December, 1946. (Cmd. 7441.) Pp. viii+204. (London: H.M. Stationery Office, 1948.) 3*s.* 6*d.* net. [187

Quarterly Bulletin of the British Psychological Society. Vol. 1, No. 1, July 1948. Pp. 36. (London: British Psychological Society, 1948.) [197

Metallurgical Abstracts (General and Non-Ferrous). Vol. 13, 1946 (New Series). Edited by S. C. Guillan. Pp. viii+553. (London: Institute of Metals, 1946.) £3. [197

Catalogues

Technique, a Journal of Instrument Engineering. Vol. 2, No. 3, July. Pp. 17–24. (Beckenham: Muirhead and Co., Ltd., 1948.)

Sunvic Evacuated Bimetal Switches. (M8. 10a.) Pp. 2. (London: Sunvic Controls, Ltd., 1948.)

VHF Direction Finder with Remote Control and Presentation. (Ref. SL. 34.) Pp. 4. Marconi Broadcasting. (Ref. SP. 12.) Pp. 12. (Chelmsford: Marconi's Wireless Telegraph Co., Ltd., 1948.)